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AUTHOR Kabat, Hugh F.; And Others
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ABSTRACT

The areas of basic science pharmacy instruction and clinical pharmacy practice and their interrelationships were identified in order to help develop didactic and clinical experience alternatives. A 10-member advisory committee ranked basic pharmaceutical science topical areas in terms of their applicability to clinical practice utilizing a Delphi technique to achieve consensus. Rankings fell within a hierarchy that included fundamental background subjects, human biological and social systems, pharmaceutical sciences, and practice applications. Committee members also identified interrelationship between the topical areas and clinical practice functions in relation to the precursor level, the content level, and the applications level. The advisory committee concluded that didactic or clinical experience alternatives focusing upon research or teaching would be more feasible and effective than those with a greater service orientation to facilitate the illustration of clinical application in basic pharmaceutical science instruction. Fifteen ways to foster the inclusion of clinical applications in basic pharmaceutical science instruction are described, including development of joint research programs and establishment of "clinical correlation conferences." For each of the basic subject areas, the percentile rankings of respondents are presented. A chart identifying clinical practice functions, their rationale, and the corresponding fundamental background area is included. References and an executive summary are included. (SW)

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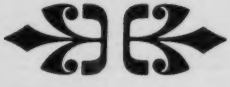
alternative methods by which basic science pharmacy faculty can relate to clinical practice

EXECUTIVE SUMMARY OF THE FINAL REPORT
September 1980



U.S. DEPARTMENT OF
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Executive Summary

The 1975 report of the Study Commission on Pharmacy Education endorsed the new patient-oriented roles of pharmacists in clinical practice settings and the clinical focus that had been introduced to pharmaceutical education. The Commission observed that pharmacy faculties have a substantial number of well-trained biological, physical, behavioral, and social scientists and some highly competent clinical practitioners, but very few clinical scientists. The Study Commission concluded that "the greatest weakness of the schools of pharmacy is the lack of an adequate number of *Clinical Scientists* who can relate their specialized scientific knowledge to the development of the practice skills required to provide effective, efficient, and needed patient services."

The Commission suggested that clinical pharmacists build upon their knowledge and skills to acquire deeper scientific knowledge, extensive pharmaceutical research skills, and a broadened understanding of disease control and management. Similarly, Ph.D.-trained pharmaceutical scientists with teaching responsibilities might develop clinical knowledge and skills that would facilitate applications of the basic pharmaceutical sciences to clinical situations.

The purpose of this study was to identify the possible relationships between pharmaceutical instruction and clinical practice, while suggesting didactic and clinical methods through which these relationships can be strengthened.

A 10-member Advisory Committee was selected for the project on the basis of experience in teaching, knowledge of both basic pharmacy instruction and clinical practice, variety of educational and clinical backgrounds, stature in the field, and geographic distribution. After an initial meeting, the Committee proceeded to utilize a three-round Delphi technique, conducted by mail.

In the first round, topics in basic pharmacy instruction were ranked in terms of applicability to the clinical practice of pharmacy. Rankings fell within a hierarchy that ranged from "Fundamental Background" subjects (the low end of the scale) through "Human Biological and Social Systems" and "Pharmaceutical Sciences" (which together formed the mid-range) to "Practice Applications."

The "basic" topic areas of pharmacy are themselves applied sciences, building upon aspects of biology, chemistry, mathematics, physics, behavioral sciences, and a broad range of human biological and social sciences. Thus, classification of individual topic areas varied considerably, with many receiving median applicability rankings near the top of the "Human Biological and Social Systems" category, or the lower end of the "Pharmaceutical Sciences" range. (Table 1.)

In round two of the Delphi, the Advisory Committee identified relationships between these topic areas and clinical practice functions. Rationales for these relationships were described in standard terms, ranging from topic areas considered "fundamental precursors of a practice function" to skill or content considered "necessary to permit exploitation of a practice function." Most frequently cited rationales included the biological, physical, or behavioral nature of the topic area, and the social setting of the practice functions. The Committee noted that basic science pharmacy instruction has application to clinical practice functions at the precursor level, the content level, and the applications level.

A study of these interrelationships indicates that each fundamental area of instruction relates to a broad array of clinical activity, and that competence in clinical practice is built upon the ability to use a broad range of content, ranging from very basic principles to highly specialized applications.

In the first two rounds of the Delphi, Advisory Committee members were encouraged to add to or delete from a preliminary staff-generated list of methods that might foster clinical applications of basic pharmaceutical science topics. In the last round of the Delphi, these alternatives were ranked by the Committee in terms of feasibility and effectiveness. (Table 2.)

The resulting list identifies methods by which pharmacy educators, basic science faculty, and clinical practitioners might capitalize on the potential for collaborative research and teaching to enhance their performance as instructors. Basic scientists can readily introduce clinical applications to their instruction without becoming clinical scientists, while clinical practitioners can illustrate basic pharmaceutical science principles using clinical situations. The Advisory Committee concluded that alternatives that focus upon research or teaching would be more feasible and effective than those with a greater service orientation. The feasibility or effectiveness of any particular alternative is a function of the interest of the educators involved, their attitudes toward one another, the availability of settings in which interaction can take place, and their willingness to make it work.

TABLE 1

Summary of Hierarchical Rank of Basic Pharmaceutical Science Areas in Terms of Applicability to Clinical Pharmacy Practice Functions

[Range is from 1(Fundamental) to 100(Applied)]

Topic Area	Median	Range	25th-75th Percentile Range
Biochemistry	50	20-80	40-80
Biopharmaceutics	85	65-100	80-90
Death and Dying	75	40-85	55-75
Dispensing	70-90	75-100	80-100
Dosage Forms	50-65	40-95	55-75
Drug Analysis-Biological Analysis	80	70-85	75-86
Drug Analysis-Quality Control	50	5-90	40-60
Drug Information Evaluation	85	50-95	85-95
Drugs and the Elderly	85	40-95	80-90
Drugs by Therapeutic Use	70-85	65-100	65-90
Emergency Medical Services	85	60-100	80-90
Human Behavior	75-85	35-95	65-80
Kinetics	20	15-90	20-40
Mathematics	20	5-80	15-80
Nomenclature	80	50-100	55-90
Nutrition	80	60-95	75-85
Pathophysiology	50-80	40-95	50-60
Pharmacokinetics	80	70-100	75-85
Pharmacology	70-80	60-95	70-85
Pharmacy Management	75-78	40-95	55-80
Physical Chemical Properties	20-30	5-75	15-60
Self Limiting Illnesses	98	80-100	93-100
Solution Chemistry	20	10-85	10-20
Systems for Health Care	60-75	30-85	45-80
Therapeutics	93	80-100	83-98
Thermodynamics	10	5-80	10-20

TABLE 2

Aternative Ways Which Would Foster the Inclusion of Clinical Applications in Basic Pharmaceutical Science Instruction

(Ranked in Order of Perceived Effectiveness and Feasibility)

1. Development of joint research programs between basic pharmaceutical scientists and clinical pharmacy practitioners to include other health related practitioners. (i.e., respiratory therapist, nursing, physicians)
2. Development of "Team Teaching Units" where basic scientists and clinical practitioners share teaching and grading responsibilities.
3. Establishment of "Clinical Correlation Conferences" to be offered by Clinical Faculty simultaneously with basic science courses (pharmacology, medicinal chemistry, etc.) with separate responsibilities for teaching and grading.
4. Establishment of "Pharmacy Patient Rounds" in which clinical and basic science faculty along with physicians and other health care personnel analyze and discuss drug therapy and patient management.
5. Establishment of joint research seminars with participation by the faculty and students from the basic sciences and clinical pharmacy disciplines.
6. Development of continuing education programs with interdisciplinary participation by basic scientists and clinical practitioners.
7. Establishment of programs to develop "Clinical Scientists" as suggested by the Millis Commission by which during sabbatical periods basic scientists will be able to participate in didactic work on pathophysiology and diagnosis of disease and in clinical activities. Factulty member in the clinical sciences, if eligible for sabbatical periods, might receive advanced training in research methodology.
8. Development of pharmacy curriculum around a "pyramid of pharmacy practice," such that a team of basic scientists and clinicians would provide background and experiences leading to attainment by the student of a specific pharmacy skill.
9. Development of multidisciplinary programs to be conducted at a national meeting on specific areas of pharmacy, e.g., national conference on cardiac arrhythmias where basic scientists in pharmacology, pharmacokinetics and medicinal chemistry would present and discuss work on

mechanism of action, pharmacokinetic discoveries, drug development and structure-activity relationships and clinical practitioners would present applications and therapeutics of new anti-arrhythmic agents.

10. Establishment of Clinical Pharmacy Review Conferences to be presented by clinical practitioners and basic science faculty to medical and other health related professions.

11. Development of "evaluation team" made up of basic scientists and clinical practitioners for supervision and assessment of clinical clerkships.

12. Establishment of "Comprehensive Pharmaceutical Consultation Units" consisting of basic scientists and clinical practitioners. These units would meet on a regular basis at a professional practice site with the objective of solving specific problems related to pharmacologic response, product selection, communications, and education.

13. Development of incentives for basic sciences faculty to relate research areas to practice needs.

14. Development of systems to identify the technology and methodology that would be of greatest value to the advancement of clinical pharmacy practice.

15. Integration of all coursework by bringing basic science and clinical faculty together in instruction and evaluation throughout the entire curriculum.

Alternative Methods By Which Basic Science Pharmacy Faculty Can Relate to Clinical Practice

Contract Number: HRA 232-78-0218

October 1, 1978 — March 15, 1980

PROJECT STAFF

Hugh F. Kabat, Ph.D. Principal Investigator
Albert I. Wertheimer, Ph.D. Co-Prinicipal Investigator
Salvador Pancorbo, Pharm.D., Ph.D. Project Director

RESEARCH ASSOCIATES

Halyna Breslawec
Abraham Hartzema
Mark Millikan
Donald North
Wendy Shyr
Donald Yu

ADVISORY COMMITTEE

William Barr, Pharm.D., Ph.D., Medical College of Virginia -Pharmacokinetics
Unamarie Clibon, Pharm.D., University of Texas - Surgery
Joel Covinsky, Pharm.D., University of Missouri at Kansas City - Adult Medicine
Dennis Helling, Pharm.D., University of Iowa - Ambulatory Care
Norman Ho, Ph.D., University of Michigan - Pharmaceutics
Henri Manasse, Ph.D., University of Illinois - Pharmacy Administration
Wendel Nelson, Ph.D., University of Washington - Medicinal Chemistry
John Rodman, Pharm.D., University of Southern California - Clinical Pharmacokinetics
Sidney Stohs, Ph.D., University of Nebraska - Pharmacognosy
Charles Walton, Ph.D., University of Texas - Pharmacology

Program Officer, **Philip R. Hugill**, Hyattsville, Maryland

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FINAL REPORT

ALTERNATIVE METHODS BY WHICH BASIC SCIENCE PHARMACY FACULTY CAN RELATE TO CLINICAL PRACTICE

The Comprehensive Report
(Covers Period of Performance Oct. 1, 1978 - March 15, 1980)

Contract No HRA-232-78-0128

Contractor
University of Minnesota
2642 University Avenue
St. Paul, MN 55114

Contractor's Project Director: Hugh F. Kabat, Ph.D.
(For other key personnel, see Preface)

Sponsor
DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Health Resources Administration
Bureau of Health Manpower
Room 4-22, Center Building
Prince George Center
3700 East-West Highway
Hyattsville, Maryland 20782

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Preface

Alternative Methods By Which Basic Science Pharmacy Faculty Can Relate to Clinical Practice

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PROJECT STAFF

Hugh F. Kabat, Ph.D. Principal Investigator
Albert I. Wertheimer, Ph.D. Co-Principal Investigator
Salvador Pancorbo, Pharm.D., Ph.D. Project Director

Research Associates

Halyna Breslawec
Abraham Hartzema
Mark Millikan
Donald North
Wendy Shyr
Donald Yu

ADVISORY COMMITTEE

William Barr, Pharm.D., Ph.D., Medical College of Virginia-Pharmacokinetics
Unamarie Clibon, Pharm.D., University of Texas - Surgery
Joel Covinsky, Pharm.D., University of Missouri at Kansas City-Adult Medicine
Dennis Helling, Pharm.D., University of Iowa - Ambulatory Care
Norman Ho, Ph.D., University of Michigan - Pharmaceutics
Henri Manasse, Ph.D., University of Illinois - Pharmacy Administration
Wendel Nelson, Ph.D., University of Washington - Medicinal Chemistry
John Rodman, Pharm.D., University of Southern California-Clinical Pharmacokinetics
Sidney Stohs, Ph.D., University of Nebraska-Pharmacognosy
Charles Walton, Ph.D., University of Texas - Pharmacology

Program Officer, Philip R. Hugill, Hyattsville, Maryland
Contracting Officer, Vincent J. Falcinelli, Hyattsville, Maryland

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ABSTRACT

The purpose of this study was to identify the various areas of basic science pharmacy instruction and clinical pharmacy practice and the interrelationships between them so that a series of didactic and clinical experience alternatives might be identified that basic pharmaceutical science educators might individually select to gain increased facility with the application of their area to clinical pharmacy practice functions. A ten member Advisory Committee ranked in a hierarchical fashion an inventory of basic pharmaceutical science topic areas in terms of their applicability to clinical practice functions utilizing a Delphi technique to achieve consensus.

Pharmaceutical sciences are essentially applications of the foundation areas and the human biological and/or social systems areas identified. They have their "roots" in these more fundamental areas so it is not hard to understand the large range or variation in some hierarchical applicability rankings for some pharmaceutical science areas. Basic science pharmacy instruction has applications to and interrelationships with a broad variety of clinical pharmacy practice functions at the precursor level, the content level and the applications level.

The Advisory Committee concluded that didactic or clinical experience alternatives focusing upon research or teaching would be more feasible and effective than those with a greater service orientation to facilitate the illustration of clinical application in basic pharmaceutical science instruction. The feasibility or effectiveness of any particular identified alternative to do this is a function of the interest of the educators involved, their attitudes toward one another, the availability of settings in which the interactions can take place, and their willingness to make it work, they concluded.

Purpose

In 1971 the American Association of Colleges of Pharmacy commissioned a study of pharmacy practice and education. The report of this Study Commission on Pharmacy titled, Pharmacists for the Future, published in 1975, stated that the objective of pharmacy education is to prepare students to practice and that teachers, actively engaged in practice, could provide effective role models. The Commission also stated "that the greatest weakness in schools of pharmacy is the lack of an adequate number of Clinical Scientists who can relate their specialized scientific knowledge to the development of the practice skills required to provide effective, efficient and needed patient services." This deficiency could be rectified by providing some practicing clinicians with rigorous training in research methodology and application such as that taught in the pharmaceutical science areas traditionally associated with the Ph.D. Alternatively some Ph.D. trained pharmaceutical scientist/educators might also fill this void by supplementing their knowledge and skills in clinical pharmacy practice to facilitate realistic and meaningful illustration of basic pharmaceutical science principles and applications in clinical practice situations. The purpose of this study was to identify the various areas of basic pharmaceutical science instruction and clinical pharmacy practice functions and the interrelationship between them so that a series of didactic and clinical experience alternatives might be identified that basic pharmaceutical science educators might individually select to gain increased facility with the application of their area to clinical pharmacy practice functions.

The mainstream functions of pharmacy have been clinical in nature for over two thousand years. Pharmacy practitioner functions - accumulation and distribution of drugs, drug information and the exercise of use control, have

remained largely unchanged over two centuries.[1] There have been substantial shifts in relative emphasis as the art of compounding was gradually replaced by the application of pharmaceutical sciences to the dispensing of manufactured dosage forms. Then more recently a clinical practice element has been introduced into pharmacy education which promises to have a profound impact.

From Colonial times until almost 1900, most pharmacists were trained by the apprenticeship method under the guidance of pharmacists who acted as preceptors. A number of private colleges were organized by local pharmaceutical associations to supplement the apprenticeship with formal lectures. However, they graduated only a few students per year and although other similar private colleges were established, their graduates numbered so few that they had little real effect upon practice standards.[2]

State universities in the midwest subsequently established the pattern for pharmacy education in the United States. By 1907, their two year course of study had become the national standard but due to the absence of academic standards, there was little uniformity in this education. Further, almost ninety percent of all pharmacist practitioners had had no formal training.[3]

The standard length of education for entry into pharmacy practice increased from two years in 1907 to three years in 1925; four years in 1932 and five years in 1960. During this period and continuing to the present, a practical experience (apprenticeship-internship) has been a continuing component of the education of pharmacists. Originally a licensure requirement, this practice experience has recently become an element in the accreditation standard for the colleges. The content of the formal college instruction has been modified over time by inclusion of new knowledge and as a result of a series of curricular studies: the most recent of which is the 1975 Report of the Study Commission on Pharmacy.[4]

More important than the increasing length of curriculum was the change in emphasis from proficiency of methods to the principles upon which the methods depend. By 1940, when the pharmaceutical manufacturing industry established the dominance of prepared standardized dosage forms, the curriculum emphasis was still largely on the operative techniques of compounding. The Pharmaceutical Syllabus came increasingly under attack from educators, practitioners and associations as too detailed, out-of-date, and too rigid, with too little general education and new material. In 1946, it was abandoned first by the American Association of Colleges of Pharmacy and then by the American Council on Pharmaceutical Education.[5]

During the 1960's, the college faculties were transfused with a cadre of young research oriented persons grounded in the scientific concepts of pharmaceutical sciences, who, within a short period of time, created a comprehensive scientific base for the profession. The profession was cast into a role firmly rooted in the physical and biological sciences relating to the dosage form at a time when the pharmaceutical industry, using these scientific principles, monopolized dosage form design through the preparation of prefabricated products. Further, the bulk of the pharmacist's formal physical and biological science education was provided by scientists who had little if any experience in practice settings. Pharmacy students received little or no instruction in clinical application and upon graduation did little to apply their scientific knowledge in practice settings. They became widely referred to as "over-educated and underutilized."[6]

Reports of hospital medication error studies in the early 1960's led to the implementation of unit dose drug distribution systems that placed institutional pharmacists in environments where they were proximate to patients and other health care providers. These pharmacists were ill equipped to deal

with the opportunities presented to them for direct clinical involvement because the general patterns of pharmacy practice were distributive in nature and their professional education prepared them primarily for this distributive function.[7]

In time a few pharmacist practitioners located in academic health centers demonstrated that their scientific and technical knowledge could be effectively applied in this practice environment. They further demonstrated that a pharmacist could function as a contributing member of a health team and lead to the improvement of patient care.[8]

In 1967 a Pharmacy-Medicine-Nursing Joint Conference on Health Education at the University of Michigan cited the need for a new direction for pharmacy education with emphasis on patient orientation, closer functioning in the clinical setting and greater closeness to the patient's bedside. This interdisciplinary group of health profession educators encouraged the development of a clinical component in pharmacy education to prepare the pharmacy student for a clinical practice.[9] In 1968, the Curriculum Committee (now Academic Affairs) of the American Association of Colleges of Pharmacy published a definition of Clinical Pharmacy and called for the initiation of clinical education in all colleges of pharmacy.

> "Clinical Pharmacy is that area within the pharmacy curriculum which deals with patient care with emphasis on drug therapy. Clinical pharmacy seeks to develop a patient-oriented attitude. The acquisition of new knowledge is secondary to the attainment of skills in inter-professional and patient communications."[10]

In 1971, Federal capitation funds became available. One condition for receipt of these funds was the provision of clinical pharmacy instruction. This expansion of clinical education resulted in a significant increase in the number of faculty in the area.

In 1975, the Report of the Study Commission on Pharmacy endorsed the new patient oriented roles of pharmacists in clinical practice settings and the clinical focus which had been introduced to pharmaceutical education. They observed that many of these roles have not yet been analyzed as to the competencies required, noting that it is difficult to identify with precision the relevant science basic to a competency which has not been clearly defined and evaluated.[11] The Commission further observed that pharmacy faculties have a substantial number of well trained biological, physical, behavioral and social scientists and some highly competent clinical practitioners but very few clinical scientists. The Study Commission concluded that "the greatest weakness of the schools of pharmacy is the lack of an adequate number of Clinical Scientists who can relate their specialized scientific knowledge to the development of the practice skills required to provide effective, efficient, and needed patient services." The Study Commission noted that medicine had resolved a similar problem by developing a cadre of scholar-practitioners equally expert at the patient's bedside and in the laboratory to assist their colleagues in the choice of those parts of their scientific discipline that are specifically and peculiarly relevant to patient care.[12-21]

The Commission then suggested that clinical practitioners build upon their knowledge and skills in clinical pharmacy to acquire deeper scientific knowledge, rigorous pharmaceutical science research skills, and a broadened understanding of disease control and management. Similarly, however, some Ph.D. trained pharmaceutical scientists with teaching responsibilities might move toward filling this need. They might build upon their scientific base and research skills by developing knowledge and skills in clinical pharmacy which would facilitate the illustration in a classroom setting of the various

principles and applications of basic pharmaceutical sciences in clinical situations.

There is a symbiotic relationship between education and practice in the health professions. The health professions have made significant strides in scientific progress since the turn of the Century. Health professional education is a blend of basic science and clinical instruction and clinical scientists are needed to identify the relevant scientific knowledge essential to the provision of patient care.

Methodology

A ten member project Advisory Committee, knowledgeable in basic science pharmacy instruction and clinical pharmacy practice, widely distributed geographically with varied education and clinical experience, who had stature in their field and were experienced teachers were utilized to rank in a hierarchical fashion the areas of basic pharmaceutical science instruction in terms of their applicability to clinical pharmacy practice; to identify the interrelationships between the various areas of basic pharmaceutical science instruction and clinical pharmacy practice and to identify a series of didactic and clinical experience alternatives that are most available which interested basic pharmaceutical science educators might select for the purpose of more effectively relating their teaching to clinical pharmacy practice.

Table 1

ADVISORY COMMITTEE SELECTION CRITERIA

1. Knowledgeable in basic science instruction and clinical pharmacy practice.
2. Wide geographic distribution.
3. Varied education or clinical experience.
4. Stature in the field.
5. Experienced teachers.
6. Some minority, handicapped, aged or veteran representation.

The members of the Advisory Committee met once, and then conducted the remainder of its activities by mail utilizing the Delphi technique.[22] Three delphi rounds were employed. In Round 1, the Advisory Committee was asked to rank a comprehensive inventory of the areas, subdivisions and subsets of basic pharmaceutical science topics (organized by staff into four general classifications - drug action, dosage form design, provision of services and fundamental background) in a hierarchical fashion on a scale of 1-100, with 100 being most applied, according to their applicability to an inventory of clinical pharmacy practice functions. The project staff provided some general range guidelines (Table 2) but the Committee could select any number between 1 and 100.

Table 2

HIERARCHICAL RANGES

1-25	Foundation Areas
26-50	Human Biological and Social Systems
51-75	Pharmaceutical Sciences
76-100	Practice Applications

Round 1 also included a list of didactic and clinical experience alternatives that could be undertaken on an individual basis by a group of individuals at a school or on a national or regional basic science disciplinary basis and the Committee was encouraged to add alternatives and to suggest modifications or deletions of those already on the list.

For Round 2, the Committee was given the median, range, and their personal hierarchical rank from Round 1 and asked to reconsider, taking into account the group median and range. In Round 2 the panel was also asked to identify the interrelationships between the areas, subdivisions, and subsets of basic pharmaceutical science instruction and the clinical pharmacy practice functions noting their rationale for the interrelationships.

In Round 3 of the delphi probe, the Committee was provided the median, range, and their personal hierarchical ranking from Round 2 and asked once more to reconsider or reaffirm. For each didactic or clinical experience alternative, they were asked to rank its relative effectiveness and feasibility. The list of alternative methods was rank ordered after assigning numerical values ranging from +3 for most effective and feasible, +2 for possibly effective and feasible, +1 for questionable effectiveness and feasibility and -1 for delete. This scaling was used by staff because members of the Advisory Committee believed that certain alternative ways may be more effective or feasible in some settings than others and so all should be included. The use of the delete value generated very low rankings for those alternative ways which Advisory Committee members felt should not be included.

Findings

A. Hierarchical ranking of areas, subdivisions or subsets of basic science instruction according to their applicability to contemporary clinical pharmacy practice functions.

Addendum II is a summary of the hierarchical rankings generated by the 3 round Delphi procedure. Values were computed for median, range and 25th-75th percentile range. In order to assess the magnitude of the overall agreement, hence the quality of the rankings, Kendall's coefficient of concordance -W was computed and tested for the total Advisory Committee and separately for the basic pharmaceutical science and clinical practitioner representatives. Kendall's test of concordance is used to verify a widely and vastly differing opinion on some series or works. The value of W ranges from 0 when there is absolutely random ranking, to 1 when there is perfect agreement in the rankings.[a]

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[a] Siegel, S., Nonparametric Statistics for the Behavioral Services, Prentice Hall, Englewood Cliffs, N.J. (1956).

Table 3

KENDALL'S COEFFICIENT OF CONCORDANCE (W)

Topic Areas	Basic Science Group N = 6	Clinical Practice Group N = 4	Total Committee N = 10
*Drug Action	.28	.57	.34
Fundamental Background	.52	.76	.53
*Provision of Services	.46	.48	.43
Dosage Form Design	.68	.82	.70

*There are significant differences between subgroup responses in these topic areas. $p < 0.05$

Table 3 summarizes the values obtained for Kendall's coefficient of concordance (W) in each of the subject areas. While the overall concordance (agreement) appears to be low for all areas other than the dosage form design area, there was more agreement between the clinical pharmacy practitioner members of the Advisory Committee than between the basic pharmaceutical science members on the applicability of all basic pharmaceutical science topic areas to clinical pharmacy practice functions. This might have been predicted because the clinical pharmacy practitioners were a more homogenous group in terms of age, training and years of post academic experience than the basic science Advisory Committee members.

Table 4

HIERARCHICAL RANK MEANS FOR FOUR GENERAL TOPIC AREAS

Topic Areas	Clinical Practice Group $\bar{X} \pm$ S.E.	Basic Science Group $\bar{X} \pm$ S.E.	Difference Between Means	P Value
Drug Action	75.4 2.4	86.0 4.0	10.6	.05
Provision of Services	69.0 2.6	71.6 4.3	2.6	.62
Dosage Form Design	67.7 0.6	71.2 4.7	3.5	.49
Fundamental Background	64.3 2.9	63.2 4.1	1.1	.82

The previously reported Kendall's test of concordance provided insight into the proximity of item rankings for the clinical practitioner and basic pharmaceutical science group members. While the degree of consensus or agreement was indicated, unknown yet were the relative rankings in each topic area by the two groups.

The only significant difference in responses between the clinical pharmacy practitioner and basic pharmaceutical science committee members was found in the Drug Action area ($P < .05$). The clinical pharmacy practitioner/educators accorded topic items a mean score of 75.4 while their basic pharmaceutical science colleagues ranked them at 86.0. The standard error values corroborate the W test results. The clinical practitioner/educator committee members were more homogenous and in agreement with each other than were the basic pharmaceutical science committee members. For all practical purposes, the mean scores between the two groups were not significantly different.

1. Fundamental Background Areas

The large variation in range, median and 25th-75th percentile range for the Advisory Committee assigned hierarchical rankings for the topic Mathematical Concepts is a function of the wide spectrum of topics included in this area. With the exception of computer systems, mathematics ranks high as a foundation area - much as kinetics and solution chemistry. There was good consensus among the Advisory Committee members that thermodynamics was even more fundamental. The Committee median values for drug analysis methods and drug product quality control suggest that these topics are fundamental to pharmaceutical sciences although the range and 25th-75th percentile range demonstrate considerable variation. The median values place drug analysis and biological chemistry topics very high in the human biological

or very low in the pharmaceutical sciences areas. There was considerable variation in range but less in the 25th-75th percentile ranges. Microbiology topic medians were similarly in the 50's and there was far less variation in either range or 25th-75th percentile. Most pharmacology topic medians were in the pharmaceutical science or practice application areas and the ranges and 25th-75th percentile ranges demonstrated consensus as Advisory Committee members ranked them either high in the human biology or low in the practice application range. There was quite good consensus that nutrition topics were at the low end of the practice application area.

Table 5

FUNDAMENTAL BACKGROUND AREAS

Summary

Topic Area	Median	Range	25th-75th Percentile Range
Biochemistry	50	20-80	40-80
Drug Analysis-Biological Analysis	80	70-85	75-85
Drug Analysis-Quality Control	50	5-90	40-60
Kinetics	20	15-90	20-40
Mathematical	20	5-80	15-80
Nutrition	80	60-95	75-85
Pathophysiology	50-80	40-95	50-60
Pharmacology	70-80	60-95	70-85
Solution Chemistry	20	10-85	10-20
Thermodynamics	10	5-80	40-60

2. Drug Action

Medians in most therapeutic classifications were on either side of 80 at the lower end of the practice application scale but the ranges were from 65-100 and the 25-75th percentile ranges in a close cluster around the medians. Therapeutics on the other hand was viewed as much more applied with medians in the middle 90's, ranges and 25th-75th percentile ranges of

80-100. Drugs for self-limiting illnesses were even more applied - medians at 98 with ranges of 80-100 but a 25th-75th percentile range of 93-100.

Table 6

DRUG ACTION

Summary

Topic Area	Median	Range	25th-75th Percentile Range
Drugs by Therapeutic Use	70-85	65-100	65-90
Nomenclature	80	50-100	65-90
Self Limiting Illnesses	98	80-100	93-100
Therapeutics	93	80-100	83-98

3. Dosage Form Design

Most of the topics relating to physiochemical properties and biological activity had medians in the high 20's but ranges of 5-85 and 15-50 in 25th-75th percentile range for the more fundamental topics. Dosage forms medians were in the 50-60 range with ranges of 50-95 and 25th-75th percentile range of 50-75 except for parenteral topics in the 80's range of medians. Dispensing, biopharmaceutics, and pharmacokinetics topics reflect their applied nature with medians in the middle to high 80's with fairly narrow range of 75-100 and 25th-75th percentile ranges of 80-100.

Table 7

DOSAGE FORM DESIGN

Summary

Topic Area	Median	Range	25th-75th Percentile Range
Biopharmaceutics	85	65-100	15-60
Dispensing	70-90	75-100	80-100
Dosage Forms	50-65	40-95	55-75
Pharmacokinetics	80	70-100	75-85
Physical Chemical Properties	20-30	5-75	15-60

4. Provision or Delivery of Pharmaceutical Services

Medians for the health care delivery and pharmacy management topics were at the low end of the practice applications area. Although the ranges were wide, the 25th-75th percentile ranges were clustered around the median. Behavioral pharmacy medians were clearly in the practice applications area, however, with wide ranges but narrow 25th-75th percentile ranges, Committee members ranked topics in Human Social Systems at the lower end of the practice application scale and the other topics considerably higher reflecting their more applied nature. Medians for emergency medical services, drug information evaluation, and drugs and the elderly were all in the vicinity of 85 with wide ranges (50-95) but narrower 25th-75th percentile ranges (80-90). Death and dying medians were on the low end of the practice applications area but ranges and 25th-75th percentile ranges revealed considerable variability.

Table 8

PROVISION OR DELIVERY OF PHARMACEUTICAL SERVICES

Topic Areas	Median	Range	25th-75th Percentile Range
Death and Dying	75	40-85	55-75
Drug Information Evaluation	85	50-95	85-95
Drugs and the Elderly	85	40-95	80-90
Emergency Medical Services	85	60-100	80-90
Human Behavior	75-85	35-95	65-80
Pharmacy Management	75-78	40-95	55-80
Systems for Health Care	60-75	30-85	45-80

B. Interrelationships between Basic Pharmaceutical Science Topic Areas and Clinical Pharmacy Practice Functions

In Round 2 of the delphi, Advisory Committee members were asked to identify the interrelationship between the basic pharmaceutical science topic areas and the clinical pharmacy practice functions noting their rationale for these decisions. Due to the variation of their backgrounds, numerous and different interrelationships were identified by individual Advisory Committee members. The Advisory Committee selected their rationale for the interrelationships from a variety of suggested rationale, (Table 9) but were free to identify other rationale also. Their responses are summarized in Addendum III which illustrates the degree of dependence of all of the clinical pharmacy practice functions upon a broad array of basic pharmaceutical science topic areas. Indeed, depending upon the level at which one might wish to consider any specific clinical practice function, the rationale might range from fundamental precursor to content areas necessary to undertake or exploit the clinical functions. A frequently cited rationale for the interrelationship was that the topic area was biological or physical or behavioral in nature. Similarly the social setting was often cited as the rationale for the interrelationship.

The principal conclusion that can be drawn from these data is that clinical pharmacy practice functions are built upon a broad understanding of content ranging from very fundamental to very applied; and the ability or skill to utilize this broad range of pharmaceutical science principles in the delivery of pharmaceutical services. The basic pharmaceutical sciences are precursors to understanding content that can be used to exploit the clinical practice functions in a variety of pharmacy settings.

Table 9

RATIONALE FOR INTERRELATIONSHIPS BETWEEN AREAS AND SUBDIVISIONS OF BASIC SCIENCE PHARMACY INSTRUCTION AND CLINICAL PHARMACY PRACTICE

1. Essential Biological or Physical Science Precursor
2. Essential Behavioral Science Precursor
3. Content (Knowledge) Area Necessary for Practice Function
4. Biological or Physical Science Application
5. Behavioral Science Application
6. Skill Practice for Function
7. Social Setting in Which Function Takes Place
8. Content or Skill Which Permits Exploitation of Practice Function
9. Other (Specify)

C. Alternative Ways Which Would Foster the Inclusion of Clinical Applications in Basic Pharmaceutical Science Instruction

In each round of the delphi, Advisory Committee members were encouraged to add to or delete from the preliminary list of alternative ways developed by staff. All Committee suggestions were included, despite some redundancy and recommendations for deletion. Several Advisory Committee members concluded that not all ways would work well everywhere but, if they might possibly be effective somewhere, then they should be included. In Round 3 of the delphi, the Advisory Committee members were asked to indicate, for each of the seventeen suggested alternative ways, those which they believed to be most effective and feasible; should be attempted but probably are not as effective or feasible; are of questionable effectiveness or feasibility and those which should be deleted. Because Advisory Committee responses were varied, perhaps due to prior experiences with one or another of the alternative ways, staff assigned a numerical weighting range from +3 to -1 to the responses to assist in developing a rank ordered list.

The individual items were then edited and rank ordered to produce the summary listing in Table 10.

Proximity between basic pharmaceutical science and clinical pharmacy educators is the key element in most of these alternative ways. The Advisory Committee ranked most favorably those ways that included a team approach to problem solving in research seminars or patient care settings. Team approaches to student instruction and continuing education for practitioners in classroom or conference settings were also highly regarded. Incentive systems, addressing technology and methodology essential for clinical pharmacy practice and integration of coursework were at the low end of the rank ordered list because many Advisory Committee members believed they should be deleted or were of questionable effectiveness or feasibility. Immersion in other environments through sabbaticals, integrated instruction by clinical and basic science faculty and multidisciplinary regional or national conferences on patient oriented problems (i.e., Congestive Heart Failure) were ranked in the middle of the feasible-effectiveness range.

The Advisory Committee ranked most effective or feasible those ways involving problem solving situations which they perceived as productive to their learning process.

Table 10

ALTERNATIVE WAYS WHICH WOULD FOSTER THE INCLUSION OF CLINICAL APPLICATIONS IN BASIC PHARMACEUTICAL SCIENCE INSTRUCTION

(ranked in order of perceived effectiveness and feasibility)

1. Development of joint research programs between basic pharmaceutical scientists and clinical pharmacy practitioners to include other health related practitioners. (i.e.-respiratory therapist, nursing physicians)

   Suggested areas could be:

   Drug Metabolism
   Pharmacokinetics
   Cost benefit analysis
   Drug Utilization Review

2. Development of "Team Teaching Units" where basic scientists and clinical practitioners share teaching and grading responsibilities. For example: One area of basic science education judged by the panel as having a high degree of applicability to clinical practice is that of "Drug Action by Therapeutic Use." For instance the pharmacological effects of anticonvulsants received a median score of 86 percent in applicability to practice. The chemical classification and structure activity relationship of analgesics received a mean score of 83 percent.

   One way which will foster the integration of Basic Science and Clinical Components in Pharmacy Education would be to develop a "Team Teaching Unit" for instruction of that phase of the curriculum dealing with "Drug Action and Therapeutic Use." This team would be composed of pharmacologists, medicinal chemists, pharmacognocists and clinical pharmacists whose responsibility would be to present this material in an integrated manner. Testing and evaluative procedures would be shared by all members of this team. Administrative procedures must be developed to organize faculties for interdisciplinary course planning and development.

3. Establishment of "Clinical Correlation Conferences" to be offered by Clinical Faculty simultaneously with basic science courses (pharmacology, medicinal chemistry, etc) with separate responsibilities for teaching and grading.

   Maintain the present system of teaching the basic components of pharmacology, medicinal chemistry and other basic elements of "Drug Action" separately. An independent course "Clinical Correlation Conference" would be added to the curriculum to provide practical applications to the material being presented concurrently in the basic discipline. Administrative procedures must be developed to

organize faculties for interdisciplinary course planning and development.

4. Establishment of "Pharmacy Patient Rounds" in which clinical and basic science faculty along with physicians and other health care personnel analyze and discuss drug therapy and patient management.

5. Establishment of joint research seminars with participation by the faculty and students from the basic sciences and clinical pharmacy disciplines.

6. Development of continuing education programs with interdisciplinary participation by basic scientists and clinical practitioners.

   Another area of basic science education which received high applicability ratings by the advisory panel was Dispensing and Intravenous Solutions and Incompatabilities. One example of an integrated continuing education program would consist of a "Total Hyperalimentation Program" to be offered to hospital pharmacists by medicinal chemists/pharmacologists discussing carbohydrates, protein, fat metabolism; a basic pharmaceutics faculty member discussing incompatibility problems and clinical pharmacists discussing practical problems dealing with hyperalimentation, i.e., catheter care, fluid rates, etc.

7. Establishment of programs to develop "Clinical Scientists" as suggested by the Millis Commission by which during sabbatical periods basic scientists will be able to participate in didactic work on pathophysiology and diagnosis of disease and in clinical activities. Faculty members in the clinical sciences, if eligible for sabbatical periods, might receive advanced training in research methodology.

8. Development of pharmacy curriculum around a "pyramid of pharmacy practice," such that a team of basic scientists and clinicians would provide background and experiences leading to attainment by the student of a specific pharmacy skill.

   Development of drug product evaluation skills would consist of coursework and practice experiences in formulation of dosage forms, biopharmaceutics and pharmacokinetics, financial management, law, ethics and pharmacy practice.

9. Development of multidisciplinary programs to be conducted at a national meeting on specific areas of pharmacy, e.g., national conference on cardiac arrhythmias where basic scientists in pharmacology, pharmacokinetics and medicinal chemistry would present and discuss work on mechanism of action, pharmacokinetic discoveries, drug development and structure-activity relationships and clinical practitioners would present applications and therapeutics of new anti-arrhythmic agents.

10. Establishment of Clinical Pharmacy Review Conferences to be presented by clinical practitioners and basic science faculty to medical and other health related professions.

    Most hospitals and medical centers routinely conduct teaching and research conferences as part of their continuing education program for their house-staff. Medicine, surgery and pediatrics Grand Rounds are examples of periodic educational presentations for medical and other health related staff. Other conferences, infectious disease, cardiology, pulmonary, etc. are part of the weekly events designed to further instruct medical personnel. Another manner in which the gap between the clinical and basic science components of pharmacy education can be narrowed is by establishment of a weekly "Clinical Pharmacy Review Conference" to be presented by the clinical and basic science faculty to medical and other health related professionals on subjects related to drugs, drug action and therapeutics.

11. Development of "evaluation teams" made up of basic scientists and clinical practitioners for supervision and assessment of clinical clerkships.

    The evaluation of clinical clerkships usually consists of oral and or written examinations designed to assess the competencies of students at the termination of a particular rotation. Part of that evaluation should involve assessment of the students comprehension of basic principles of pharmacology, structure-activity relationships, patient communications, etc. One additional way to bridge the gap between the clinical and basic sciences would be for individuals from each group to work together in the development of evaluation and evaluative procedures for clinical clerkships.

12. Establishment of "Comprehensive Pharmaceutical Consultation Units" consisting of basic scientists and clinical practitioners. These units would meet on a regular basis at a professional practice site with the objective of solving specific problems related to pharmacologic response, product selection, communications, and education.

    Most hospital pharmacy departments face a multitude of problems dealing with pharmaceutical bioequivalence and product selection, distribution systems, pharmacokinetic services, systems management, continuing education, and research. Comprehensive Pharmaceutical Consultation Units made up of basic scientists in pharmacology, pharmacokinetics and pharmacy administration as well as hopsital pharmacy staff and clinical practitioners would meet periodically in order to address specific problems of the institution.

13. Development of incentives for basic sciences faculty to relate research areas to practice needs.

14. Development of systems to identify the technology and methodology that would be of greatest value to the advancement of clinical pharmacy practice.

15. Integration of all coursework by bringing basic science and clinical faculty together in instruction and evaluation throughout the entire curriculum.

Discussion and Implications

A. Hierarchical ranking of basic pharmaceutical science topics according to their applicability to clinical pharmacy practice functions.

The advisory Committee was asked to rank the areas, subdivisions and subsets of basic science instruction in a hierarchical fashion according to their applicability to an inventory of clinical pharmacy practice functions. They were provided with a scaling guide but had the freedom to select any rank. (Table 2)

Thus each grouping of topics had its own applicability ranking interval ranging from very fundamental to very applied. Measures of central tendency (median) and dispersion (range) (25th - 75th percentile ranges) were calculated as a measure of the Advisory Committee's consensus. There was very little change in Advisory Committee responses from Round 2 to Round 3.

The "basic" pharmaceutical sciences topic areas are in themselves applied, building upon fundamental areas like biology, chemistry, mathematics, physics and behavioral sciences and a broad base of human biological and social sciences. Thus it is not chance that many topic areas received median applicability to clinical practice rankings close to the top of the Human Biological and Social Systems range or near the least applicable or fundamental part of the Pharmaceutical Sciences range. In general the basic pharmaceutical science Advisory Committee members gave basic science topical areas higher applicability rankings than did the clinical practitioner Advisory Committee members. The difference in their applicability perception could be a function of one or more factors. It could occur because basic pharmaceutical science Advisory Committee members, due to their backgrounds, see far more applications than do their

clinical practitioner colleagues, or that what they perceive as applicability in principle is not of consequence or relevant in practice, or that if the clinical practitioner members possessed depth of basic pharmaceutical science similar to their basic science colleagues, they would similarly sense greater applicability.

Most biological science topics received relatively higher applicability rankings than did physical science topics. This is a reflection, no doubt, of the current biological emphasis of the basic pharmaceutical sciences which historically has had a more physical science orientation. Clinical pharmacy practice functions utilize the more biological basic sciences to a greater degree than they do the physical sciences. This is not to say, however, that physical sciences are unimportant or do not have applications to clinical pharmacy practice functions but perhaps that no one has forcefully articulated and demonstrated their applicability. It perhaps corraborates more than anything else the conclusion of the Study Commission on Pharmacy that there is a need for pharmacy educators who are well skilled in both science and clinical practice "who can assist their colleagues in making the choice of those parts of their scientific discipline that are specifically and peculiarly relevant to patient care and must have the highest priority in the curriculum".

B. Rationale for interrelationships between basic pharmaceutical science topic areas and clinical pharmacy practice functions.

The Advisory Committee identified a large number of interrelationships between the areas, subdivisions and subsets of basic science instruction and clinical pharmacy practice functions. For instance, the basic science topic, Drug Action By Therapeutic Use, is an element in the following clinical pharmacy practice functions:

Communications in the Health Care Setting
Drug Product Evaluation
Drug Information Retrieval
Poison Identification and Treatment
Emergency Care Assessment and Treatment
Design, Administration and Monitoring of Intravenous Therapy
Selection and Assessment of Non-Drug Therapy

The rationale for these interrelationships cited by Advisory Committee members included the following:

A content area for a clinical function.
Permits a practitioner to exploit a clinical function in the interest of patient care.
An application of a biological or physical science principle.
An essential biological or physical science precursor.
Provides a student with the opportunity to practice a skill necessary to accomplish a clinical practice function.

Similarly one might look at the clinical pharmacy practice functions that have interrelationships with basic pharmaceutical science topic areas. For instance, Communicating in the Health Care Setting utilizes a variety of basic pharmaceutical science topics including the following:

General Pharmacological Principles
Human Nutrition
Health Science Terminology
Drug Nomenclature and Classification
Drug Action By Therapeutic Class
Therapeutics, Monitoring, Efficacy and Patient Education of Major Diseases
The Health Care System
Human Behavior
Emergency Medical Services
Drugs and the Elderly
Death and Dying

In summary, it is evident that basic pharmaceutical science instruction is interrelated with a broad range of clinical pharmacy practice functions because it is a fundamental principle, an application, a content area for the function, an opportunity to practice the function and/or it permits the practitioner to exploit the function to the patient's benefit.

C. Alternative Ways which would foster the integration of clinical applications in basic pharmaceutical science instruction.

In reviewing the edited list of alternative ways, they can be segregated into the traditional academic profile categories of teaching, research and service. Table II summarizes this delineation.

Table II

ALTERNATIVE WAYS
TEACHING, RESEARCH AND SERVICE PROFILES

Teaching	Research	Service
2. Team Teaching Units	1. Joint Research Programs	4. Pharmacy Patient Rounds
3. Clinical Correlation Conferences	5. Joint Research Seminars	12. Consultation Units
6. Interdisciplinary Continuing Education	7. Sabbaticals	13. Incentives
8. Practice Pyramid	9. Multidisciplinary Research Meetings	
10. Pharmacy Review Conferences	14. Practice Research	
11. Evaluation Teams		
15. Coursework Integration		

Most of the high ranked "ways" are related to teaching or research and indeed they are mutually supportive rather than mutually exclusive. Service related "ways" were limited in number and many Advisory Committee members found them to be of questionable effectiveness or feasible, suggesting that joint participation in service activities was perceived to be of little value.

Implicit in all of these "ways" is the need to build actual working relationships between basic pharmaceutical scientists and clinical pharmacy practitioner educators. If this is to occur, then the administrative structure and the reward system of academic institutions must prioritize this with respect to other educational missions.

The alternative way which produced the most divergent Advisory Committee response was the "way" relating to development of systems to

identify the technology and methodology that would advance clinical pharmacy practice. Half of the Advisory Committee cited this as effective or feasible or probably effective or feasible and half recommended deletion of the "way". Research on practice was one of the areas which the Study Commission on Pharmacy cited as needing some priority. Perhaps, however, this is a reflection of the status accorded to fundamental research as contrasted with applied research.

D. Implications for Future Directions in Pharmacy Education

Pharmacy education will continue the evolutionary process documented in Chapter 2. The development of a scientific base in pharmaceutical sciences and the introduction of clinical practitioners to pharmacy education is a fairly recent phenommenon and too recent to have had its full impact.

The needs of clinical practitioners for an increasingly biological focus is already occurring. Pharmaceutical science disciplines have been moving in this direction as the patient focus has become more apparent. The mix of basic scientist faculty is likely to move to more biologically oriented disciplines and the traditionally physical science oriented disciplines may be expected to continue their increasingly biological focus.

Basic pharmaceutical science instruction can be expected to continue to include clinical applications for the purpose of illustrating its relevance, significance and applicability to clinical practice. As clinicians begin to publish, the literature will contain a growing number of practice applications which can be cited. Not every basic scientist should be expected to be a clinical problem solver nor should every clinical practitioner be expected to become a clinical scientist. The

academic and political institutions of pharmacy can foster the inclusion of clinical applications in basic pharmaceutical science instruction by organizing and facilitating continued joint collaborative working relationships between basic pharmaceutical scientist and clinical practitioner educators.

To this end, political organizations such as the American Association of Colleges of Pharmacy, the American Pharmaceutical Association, the American Society of Hospital Pharmacists and their local counterparts should foster programs that will build working relationships between basic pharmaceutical scientists and clinical practitioners. Their working relationships can include integrated research, teaching, curriculum development and/or role development. This will occur over time, in any case, but these organizations may significantly reduce the time necessary to bring it about.

Conclusions

The 1975 Report of the Study Commission on Pharmacy, Pharmacists for the Future, identified as the greatest weakness of schools of pharmacy, the lack of an adequate number of clinical scientists who can relate their specialized knowledge to the development of the practice skills required to provide effective, efficient and needed patient services. The purpose of the study was to identify the various areas of basic science pharmacy instruction and clinical pharmacy practice; to hierarchically rank them in terms of their applicability to clinical pharmacy practice and to indicate the interrelationships between them so that a series of didactic and clinical experience alternatives might be identified in which College of Pharmacy educators might individually choose to participate so that the Commission-identified weakness in schools of pharmacy might be addressed, until such time as Clinical Scientists are available to assist their colleagues to identify those parts of their scientific discipline must have the highest priority in the curriculum due to their relevance to patient care.

The Advisory Committee was able to achieve reasonable consensus about the applicability of many basic science pharmacy instructional topics to clinical pharmacy practice functions as demonstrated by numerous hierarchical ranks that had narrow ranges and/or 25th-75th percentile ranges across the spectrum of topic areas including fundamental background areas (i.e., thermodynamics, kinetics, solution chemistry, drug analysis, pharmacology, pathophysiology and nutrition), drug action (i.e., therapeutics, self limiting illnesses), dosage form design (i.e., dispensing, biopharmaceutics and pharmacokinetics) and delivery of pharmaceutical services (i.e., emergency medical services, drug information evaluation, drugs and the elderly). The broad ranges for other topics were no doubt caused by the

particular focus that the Advisory Committee member had on the topic. This was evident from the interrelationship responses where the rationale for an interrelationship between an instructional topic and a clinical pharmacy practice function often ranged from fundamental essential biological, physical or behavioral precursor to content area for practice to clinical application, or permits exploitation of the clinical function. This would explain some of the Advisory Committee variation.

Pharmaceutical sciences are essentially applications of the foundation and the human biological and/or social system areas identified. They have their "roots" in a broad range of fundamental areas so it is understandable that there is a large range or variation in some hierarchical applicability rankings for some pharmaceutical science topic areas. Basic science pharmacy instruction has applications to a broad variety of clinical pharmacy practice functions at the precursor level, the content level and the applications level.

The Advisory Committee identified a series of alternative "ways" by which pharmacy educators, basic science, and clinical practitioners might increase their interaction for the purpose of improving their understanding expertise and needs so that both might capitalize on this potential in collaborative research and teaching and to enhance their personal teaching. It is possible for basic scientists in pharmacy to introduce clinical applications to their instruction without becoming clinical scientists. Similarly clinical practitioners can use clinical situations to illustrate basic pharmaceutical science principles. The Advisory Committee concluded that alternative ways focusing upon reasearch or teaching would be more feasible and effective than those with a greater service orientation since both basic science and clinical practice faculty can contribute their

special expertise while benefiting from the group interaction. The feasibility or effectiveness of any particular alternative to foster the inclusion of clinical applications in basic pharmaceutical science instruction is a function of the interest of the educators involved, their attitudes toward one another, the availability of settings in which the interactions can take place, and their willingness to make it work.

ADDENDUM I

Bibliography

1. Brodie, D.C. The Challenge to Pharmacy in Times of Change, Washington D.C., The Commission on Pharmaceutical Services to Ambulant Patients by Hospitals and Related Facilities, Amer. Pharm. Assoc. and Amer. Soc. Hosp. Pharm., 1966.

2. Smith M.C. and Knapp, D.A. Pharmacy, Drug and Medical Care, 2nd Ed., Williams and Wilkins, Baltimore 1976, p. 69.

3. Sonnendecker, G. Kremer's and Urdang's History of Pharmacy, 4th Ed., J.B. Lippincott, Philadelphia, PA (1976) pp. 226-254.

4. Mrtek, R.G. Pharmaceutical Education in the United States, Amer. J. Pharm. Educ. 40:340 (1976).

5. Mrtek, Ibid, p. 352.

6. Johnson, R.E. and Greenlick, M.R. Amer. J. Pharm. Educ. 33:361 (1969).

7. Durant, W. and Zilz, D. Amer. J. Hosp. Pharm. 25:172 (1968).

8. Brodie, D.C. and Benson, R.A. The Evolution of the Clinical Pharmacy Concept, Drug Intell. Clin. Pharm. 10:506, 1976.

9. Proceedings: Pharmacy-Medicine-Nursing Conference on Health Education, Ann Arbor, Michigan, Feb. 16-18, 1967.

10. Anon, Amer. J. Pharm. Educ. 32:435 (1968).

11. Pharmacists for the Future, Health Administration Press, Ann Arbor, Michigan, 1975, p. 123.

12. Flexner, A. Medical Education in the United States and Canada, Boston, Mass., Updike, 1910.

13. Visscher, M., The Decline in Emphasis on Basic Medical Sciences in Medical School Curricula, Ala. J. Med. Sci. 11(3):215 (1974).

14. Campbell, E.J.M. Basic Science, Science, and Medical Education, Lancet 1:134 (Jan. 17) 1976.

15. Visscher, M.B. Basic Scientific Education For the Future of Medicine, Federation Proceedings 33(9):1966, 1974.

16. Bowsher, D. What Should be Taught in Anatomy, Med. Educ. 10:132 (1976).

17. Gralla, E.J., Teaching Toxicology as a Basic Medical Science, J. Med. Educ. 51:115, 1976.

18. Khayan-Baslic, H. Toward a Clinical Orientation in the Basic Medical Biochemistry Curriculum, Med. Educ. 12:186 (1978).

19. Tranill, A.A. The Anatomical Basis of Clinical Practice: An Anatomy Learning Programme, Med. Educ. 11:377, 1977.

20. Eugel, G.L. Biomedicines's Failure to Achieve Flexnerian Standards of Education, J. Med. Educ. 53:387, 1978.

21. Becker, H.S. Education for the Professions, University of Chicago Press, Chicago, IL., 1962, p. 27-46.

22. Rakich, J.S., Longest, B.B., O'Donovan, R.R. Managing Health Care Organizations, W.B. Saunders Company, Philadelphia, 1977, p. 98.

ADDENDUM II

MEDIAN, RANGE AND 25th-75th PERCENTILES FOR ADVISORY COMMITTEE HIERARCHICAL RANKING OF AREAS OF BASIC PHARMACEUTICAL SCIENCE

Fundamental Background Areas

Median	Range	25th-75th Percentile	
			I. Mathematical
23	5-80	13-40	A. Basic Concepts(Significant figures, exponents, powers, roots, and logarithms
20	10-50	15-20	B. Calculus (Differential and integral)
48	15-75	20-60	C. Statistical Concepts (Parametric and non parametric tests)
21	15-50	15-25	D. Probability
75	10-85	37-80	E. Computer Systems
			II. Physical Chemistry
11	5-51	8-18	A. Thermodynamics
11	5-51	8-18	1. First Law of Thermodynamics (Enthalpy, heat capacity, standard states)
11	5-51	8-18	2. Second Law of Thermodynamics (Entropy, reversible vs. irreversible, Gibb's Free Energy, ideal states)
11	5-51	8-18	3. Third Law of Thermodynamics (Entropy, efficiency)
11	5-51	8-18	4. Thermochemistry (Heat of formation, reaction, combustion, and solution)
-	-	-	B. Kinetics
21	5-80	18-35	1. Molecular Behavior(Maxwell Boltzmann Distribution, molecular partition function)
22	15-90	20-40	2. Reaction Order (0, First, Second)
22	15-90	20-40	3. Mechanism of Chemical Kinetics(Catalysis-free energy of activation), oxidation reduction, complexation, hydrolysis, photochemical)

Median	Range	25th-75th Percentile	
15	0-55	0-20	C. Solution Chemistry
19	10-55	13-20	1. Intermolecular Interaction (Free energy change, electron interactions, activity coefficients (Debye-Huckle), force between molecules)
20	10-85	13-23	2. Solubility (Homogenous equilibrium, Lowry Bronsted (pH, pKa, pKb), buffer capacity, chemical equilibrium (acid/base), temperature effects, particle size effects)
20	8-85	10-20	3. Heterogeneous Equilibraum (Phase Diagrams)
19	10-85	10-20	4. Colligative Properties (Freezing point depression, osmotic pressure, partition coefficient)
20	10-85	13-20	5. Dissolution Theory
20	10-85	13-20	a. Interfacial phenomema (Surface tension, absorption, wetting, adhesion)
20	10-85	13-20	b. Rheology (viscosity and fluidity)
			III. Pharmaceutical Analytical Chemistry
6	5-65	--	A. Drug Analysis Methods
31	5-65	15-52	1. Gravimetric Analysis
31	5-65	20-51	2. Volumetric Analysis (titrimetric)
51	5-80	23-59	3. Spectrophotometric Analysis (UV spectrophotometrics
51	5-80	33-59	4. Chromatography (Column, thin-layer, gas-liquid, high pressure liquid (hplc), gas-mass spec., and fluorometric analysis)
50	5-75	15-52	5. Radioisotopes and radioactivity
50	5-75	23-52	a. Origin and decay of various types of radiation (α,β,δ)
50	5-75	18-52	b. Calculation of specific activity
50	5-75	18-52	c. Scintillation applications

Median	Range	25th-75th Percentile	
51	5-90	--	B. Drug product quality control
51	5-90	38-58	1. Quantity variation (Final product testing
51	5-90	38-58	2. Unit to unit consistency (In process control)
51	5-90	38-58	3. Freedom from extraneous substances (Final product testing)
51	5-90	38-58	4. Stability (Final product testing)
51	5-90	38-58	5. In vitro disintegration and dissolution testing
56	5-90	50-65	6. Biological availability (Final product testing)
80	70-85	--	C. Drug analysis in biological fluids
81	70-85	78-85	1. Normal values
81	70-85	78-85	2. Renal function
81	70-85	75-83	3. Liver function
81	70-85	75-83	4. Drug induced modifications
			IV. Biological Chemistry
43	20-60	--	A. Molecular components of cells
49	20-90	38-50	1. Amino acids
49	20-80	38-50	2. Proteins (Confirmation, characterization)
43	20-60	--	3. Enzymes
48	20-60	35-50	a. Kinetics (Michaelis-Menten)
43	20-60	35-50	b. Inhibition (Linweaver-Burke)
43	20-60	33-50	c. Mechanism of action
43	20-60	28-50	d. Regulation
48	20-60	33-50	e. Enzyme cofactors
49	20-70	38-50	4. Carbohydrates (Sugars, storage polysaccharides)

Median	Range	25th-75th Percentile	
49	20-70	38-50	5. Lipids and Lipoproteins (Membranes)
49	20-70	38-50	6. Nucleic Acids (Structure, nucleotides)
45	40-60	--	B. Metabolism
48	40-80	--	1. Carbohydrate
48	20-80	40-60	a. Glycolysis (Embden-Meyerhof)
48	25-80	40-60	b. Krebs Cycle
48	20-80	40-60	c. Glycogen Synthesis
48	30-80	40-60	d. Gluconeogenesis
50	25-80	40-60	e. Pentose Phosphate Pathway
50	40-80	--	2. Lipid
50	25-80	40-60	a. Lipolysis
50	30-80	40-60	b. Fatty Acid Synthesis
50	30-80	40-60	3. Protein
50	30-80	40-60	4. Interrelationship between carbohydrate, lipid and protein metabolism (Physiological, cellular)
50	25-80	40-60	5. Metabolic control mechanisms
50	30-60	40-60	6. Energy transfer pathways. (ATP cycle, electron transport system (oxidation-reduction), oxidative phophorylation, metabolic compartmentation)
52	40-60	40-60	C. Mechanism of action and control mechanisms of hormone action
52	40-60	40-60	1. Protein
52	40-60	40-60	2. Steroid
50	30-65	38-50	D. Replication, transcription and translation of genetic information
50	30-65	38-50	1. Biosynthesis of protein (Translation)

Median	Range	25th-75th Percentile	
50	30-65	38-50	2. The genetic code
50	30-65	45-50	3. Regulation of gene expression
18	50-85	--	V. Microbiology
51	40-85	48-70	A. Host parasite relationships
51	40-85	48-70	1. Pathogenicity (invasiveness, toxigenic factors and symbiosis)
51	40-85	48-70	2. Isolation and identification of Pathogenic Microbes
51	40-85	48-70	3. Normal flora types, function and super-infection
51	45-85	48-78	B. Host defense mechanisms
51	45-85	48-78	1. Skin and mucous membranes
51	45-85	48-78	2. Acute, chronic and subacute inflammatory response
51	45-85	48-78	3. Phagocytosis
51	45-85	48-78	4. Acquired specific immunity
51	45-85	48-78	a. Humoral immune response
51	45-85	48-78	b. Cellular response
51	45-85	48-78	c. Properidine alternate systems
50	50-85	--	C. Immunology
52	40-85	50-78	1. Cytology and histology of immune response
52	40-85	45-78	a. Cells in blood (Platelets, granulocytic white blood cells, and agranulocytic cells)
52	40-85	50-78	b. Tissue cells (Mast cells, macrophages, and plasma cells)
52	40-85	50-78	c. Anatomy, pathology, and function of Lymphoid Organs (Thymus, spleen, lymph node, and lymphoid nodules)

Median	Range	25th-75th Percentile	
53	45-85	50-75	2. Structure, biological properties and presence of IMMUNOGLOBULINS in disease states (IgG, IgA, SIgA, IgM, IgD, IgE)
53	45-85	50-73	3. Serum complement system (Importance, methods of measuring, effect on hemodialysis and control mechanisms)
53	45-85	50-80	4. Antigen and antibody interactions (Haptens, agglutination, precipitation, labelled Ab and indirect techniques)
60	50-85	50-80	5. Hypersensitivity (Immediate and delayed)
53	45-85	50-80	6. Immunological self and transplants (Graft types, histo compatability antigens, human organ transplantations, transplantation resistance, tissue typing, HL-a Human Leukocyte Antigen Typing, immunosuppressive agents, and blood transfusion)
53	25-85	50-80	7. Tumor Immunology (Tumor specific transplant antigens, cross reaction, immune serveillance, tumor products (diagnostic), and tumor types)
63	50-85	50-85	8. Pathology and treatment of immune deficiency disease (Deficient immune response, immune complex, autoimmune disease, immune injury)
			VI. General Pharmacological Principles
71	60-95	60-76	A. Modes of drug action (Initiation, modulation or destruction of cell)
71	60-95	63-76	1. Extracellular
71	60-95	60-86	2. Intracellular (cells, and cell membranes)
70	60-95	63-76	B. Drug-Cell Interactions
70	60-95	63-76	1. Drug action and effect--the receptor theory (Clarke-Ariens-Stephenson biological responses model)
70	60-95	63-76	2. Selectivity and Specificity
70	60-95	63-76	3. Mechanisms

Median	Range	25th-75th Percentile	
70	60-95	63-76	a. Direct
70	60-95	63-76	b. Indirect
70	60-95	63-76	1) Endogenous substance release
70	60-95	63-76	2) Prevention of endogenous substance metabolism
70	60-95	63-76	3) Prevent of endogenous substance synthesis of release
70	60-95	63-76	4) Reflex effect caused by primary drug effect
70	60-95	63-76	c. Nonreceptor mediated drug action
80	65-95	--	C. Dose-Response Relationships (Efficacy, maximum efficacy, ED_{50}, LD_{50}, and potency (dosage))
81	65-95	80-83	1. Dosage
80	65-95	73-83	2. Types of Drug Responses
80	65-95	73-83	a. Quantal (all-or-none)
80	65-95	73-83	b. Measured (graded) (Mass action, partial agonists, and drug-receptor complex)
80	65-95	73-83	c. Drug interactions may modify ADEM Competitive antagonism, noncompetitive, functional antagonism, chemical antagonism, additive or synergism effect)
81	65-95	78-88	3. Therapeutic indicies of dose-response relationships
80	75-95	--	D. Physiologic distribution of drugs (ADEM, drug plasma concentrations, kinetics, response intensity: free drug conc)
81	75-95	--	1. Absorption (Route, rates, and factors affecting)
81	75-95	75-85	a. Passive transport
81	50-95	75-85	b. Active transport

Median	Range	25th-75th Percentile	
81	75-95	75-85	2. Distribution (Mixing, and diffusion) [Body water, blood flow, gastric and C-S fluids, adipose and pigmented tissues, hair, nails, liver, brain, bone, uterine secretions and organs of excretion]
81	75-95	75-85	a. Drug physiochemical properties
81	75-95	75-85	b. Protein binding
81	75-95	--	3. Metabolism (biotransformation)
81	50-95	75-85	a. Sites [liver (microsomes, cytosol, mitochrondria), lung, kidney, blood, intestine]
81	60-95	75-85	b. Types
81	60-95	75-85	1) Degradation (Oxidation, reduction, hydrolysis)
81	75-95	--	c. Pathways (Microsomal, nonmicrosomal, misc.)
81	75-95	75-85	1) Factors influencing route
81	65-95	75-85	2) Hepatic cytochrome P-450 dependent sytems
81	75-95	75-85	4. Excretion (Types, half-life, routes, active transport, passive reabsorption)
79	65-95	--	E. Toxicology
80	65-95	--	1. Expressions of toxicity
80	65-95	70-80	a. LD_{50}, LD50/ED50, TD_{50}
80	65-95	75-80	b. Margin of safety
80	60-95	70-80	c. Toxicity rating
81	65-95	75-80	2. Types of toxicity (acute, subacute, chronic, delayed)
81	65-95	--	3. Treatment of toxicity
81	60-95	73-83	a. Supportive therapy

Median	Range	25th-75th Percentile	
81	65-95	80-83	b. Antidote
81	65-95	75-83	c. Emesis/lavage
80	65-95	73-83	4. Mechanism of action
80	50-95	70-83	5. Poisonous Plants (Alkaloids, amines and toxalbumins, phenanthrenes, cyanogenic glycosides, oxalates, resinoids and latexes and mushrooms
80	65-95	73-80	6. Environmental toxicity
80	65-95	73-80	a. Pesticides
80	65-95	73-80	b. Air pollution (SO_2, CO)
80	65-95	73-80	c. Lead, mercury, arsenic and iron
80	65-95	73-80	d. Food additives
83	65-95	80-90	7. Poison centers
			VII. Physiology and Pathophysiology
51	40-95	48-60	A. Cellular Physiology
51	40-95	48-60	1. Chemical composition
51	40-95	48-60	2. General cell structure
51	40-95	48-60	3. Cell membrane
51	40-95	48-60	a. Transport
51	40-95	48-60	b. Cell membrane potentials
51	40-95	48-60	4. Cellular metabolism
51	40-95	50-60	5. Nucleus (Morphology, function)
52	45-95	50-60	B. Biological Control
52	45-95	50-60	1. Homeostasis
52	45-95	50-60	2. Chemical mediators
52	50-95	--	C. Neural control mechanisms

Median	Range	25th-75th Percentile	
53	50-95	50-60	1. Neuron
53	50-95	50-60	2. Synapse
53	50-95	50-60	3. Peripheral system afferent
53	50-95	50-60	4. Peripheral-efferent
53	50-95	50-60	a. Somatic
53	50-95	50-60	b. Autonomic
53	50-95	50-60	5. Central nervous system
52	50-95	50-55	6. Blood brain barrier
52	50-95	50-55	7. Cerebrospinal fluid
53	50-95	50-55	D. Hormonal Control
53	50-95	50-60	1. Mechanics of Hormone Action
53	50-95	50-68	2. Control of Hormone Secretion
53	50-95	50-68	3. Metabolic Disorders (Hypothalamus, Pituitary, Adrenal, Tyroid)
41	40-95	--	E. Muscle
51	40-95	45-65	1. Structure of Skeletal Muscle
51	40-95	45-65	2. Molecular Basis of Contraction
51	40-95	45-65	3. Membrane Excitation
51	40-95	45-65	4. Mechanics of Membrane contraction
51	40-95	45-65	5. Energy metabolism
51	40-95	45-65	6. Smooth Muscle
52	40-95	45-65	7. Cardiac Muscle
63	50-95	--	F. Cardiovascular Disorders-symptomology, etiology, diagnostic tests
73	40-95	55-80	1. Heart Process

Median	Range	25th-75th Percentile	
73	40-95	55-80	a. Heart Beat Coordination (late diastole, systole, early diastole)
73	40-95	55-80	b. Cardiac output
73	40-95	55-80	2. Heart Control Mechanisms (heart rate, stroke volume)
70	50-95	55-80	3. Vascular System
70	50-95	55-80	a. Blood Pressure
70	50-95	55-80	b. Control of Blood flow through Arteries, Arterioles, Capillaries, Veins
68	35-95	55-80	4. Lymphatic System
68	50-95	50-80	5. Integration of Cardiovascular function
73	50-95	55-80	a. Arterial pressure, cardiac output, arteriolar resistance
70	50-95	55-80	b. Cardiovascular and afferent pathways
70	50-95	55-80	c. Receptors (baroreceptors, chemoreceptors)
79	45-95	63-80	6. Pathology
79	45-90	63-80	a. Shock, hemorrhage and hypotension
79	45-95	63-80	b. Hypertension
79	45-95	63-80	c. Congestive Heart Failure
79	45-95	63-80	d. Infarctions
79	45-95	63-80	e. Blood vessel disease
79	45-95	63-80	f. Thrombosis (arterial, cardiac)
79	45-95	63-80	g. Developmental Anomalies
79	45-95	63-80	h. Acquired Heart disease (Rheumatic Heart Disease, Endocarditis, Dysrhythmias)

Median	Range	25th-75th Percentile	
79	45-95	63-80	i. Lymphoid system disorders
79	60-95	--	G. Respiratory Disorders-symptomology, etiology, diagnostic tests.
78	50-95	55-80	1. Mechanism (Inspiration, Expiration, Pressure Gradients)
78	40-95	55-80	2. Gas Exchange and Transport (Oxygen, CO_2, Hemoglobin)
78	45-95	55-80	3. Control (Ventilatory Volume, Exercise, High Altitude)
68	45-95	55-80	4. Erythrocyte & Hemoglobin Balance (Anemias, Leukemias)
79	45-95	63-80	5. Clinical Syndromes
79	45-95	63-90	a. Obstructive diseases (Bronchitis, Emphysema)
79	45-95	63-80	b. Pneumonia
79	45-95	63-80	c. Tuberculosis
79	45-95	63-80	d. Pulmonary edema
79	45-95	63-80	e. Pleurisy
79	45-95	63-80	f. Asthma
79	60-95	--	H. Kidney and Urinary Tract Disorders-symptomology, etiology, diagnostic tests
79	45-95	63-80	1. Renal Processes
79	46-95	63-80	2. Urinary Tract
79	45-95	63-80	3. Sodium, Chloride + Water Regulation
79	45-95	63-80	4. Potassium, Calcium + Hydrogen Ion Regulation (Buffering of H^+, Bicarbonate-CO_2)
80	45-95	63-80	5. Kidney Disease
80	45-95	63-80	a. Acute renal failure

Median	Range	25th-75th Percentile	
80	45-95	63-80	b. Glomerulonephritis
80	45-95	63-80	c. Artificial kidney
79	45-95	63-80	6. Bladder Disease
79	45-95	63-80	a. Obstruction
79	45-95	63-80	b. Neurogenic (M.S., Diabetes effects)
79	50-95	--	I. Digestive Tract (Gut) Disorders-symptomology, etiology, diagnostic tests
79	50-95	63-80	1. Mouth/Pharynx and Esophagus
79	50-95	63-80	2. Stomach
79	50-95	63-80	a. Gastric Motility
79	50-95	63-80	b. Gastric Secretions (H Cl, Enzyme, secretion controls)
79	50-95	63-80	c. Absorption
79	50-95	63-80	3. Pancreatic secretions and controls
79	50-95	60-80	a. Bicarbonate
79	50-95	60-80	b. Enzyme
79	50-95	63-80	4. Small Intestine
79	50-95	63-80	a. Motility
79	50-95	63-80	b. Digestion and Absorption
79	50-95	60-80	5. Large Intestine
79	50-95	60-80	a. Absorption
79	50-95	60-80	b. Motility
68	45-96	--	J. Reproduction Disorders-symptomology, etiology, diagnostic tests
73	45-95	63-80	1. Male
73	45-95	63-80	2. Female (Menstruation, Fertilization, Paruition, Lactation)

Median	Range	25th-75th Percentile	
68	45-95	63-80	3. Pathology
68	45-95	60-80	a. Carcinomas
73	45-95	63-80	b. Menstrual Disorder
68	45-95	58-80	c. Toxemia, Abortion, Placental Abnormalities
70	45-95	--	K. Bones, Joints and Connective Tissue Disorders-symptomology, etiology, diagnostic tests
70	45-95	--	1. Pathology - Bones
70	45-95	63-80	a. Osteomalacia - Osteoporosis
70	45-95	60-80	b. Tumors
70	45-95	63-80	c. Bone marrow diseases
73	45-95	63-80	2. Arthritis
73	45-95	63-80	3. Gout
73	35-95	--	L. Skin anatomy, function and disorders-symptomology, etiology, diagnostic tests
73	35-95	--	1. Pathology
79	35-95	63-80	a. Dermatitis and Eczema
78	35-95	63-80	b. Psoriasis
79	63-80	63-80	c. Inflammation
79	63-80	63-80	d. Acne vulgaris
73	35-95	55-80	e. Moles
73	35-95	55-80	f. Tumors
78	35-95	63-80	M. Eye, Ear and Nose Disorders-symptomology, etiology, diagnostic tests
78	35-95	63-80	1. Conjunctivitis, cataract, glaucoma
78	35-95	63-80	2. Ear infections

Median	Range	25th-75th Percentile	
79	60-95	--	3. Allergic rhinitis
78	35-95	63-80	N. Nervous System and Muscle Disorders- symptomology, etiology, diagnostic tests
78	35-95	63-80	1. Cerebral Edema (Trauma)
79	60-95	--	2. Cerebrovascular Disease
79	60-95	68-80	a. Hemorrhage
80	60-95	70-80	b. Embolism
80	60-95	70-80	c. Thrombosis
80	60-95	70-80	3. Seizure Disorders
80	60-95	70-80	4. Alcoholism
80	60-95	70-80	5. Myasthemia Gravis - Multiple Sclerosis
80	60-95	70-80	6. Tetanus
80	55-95	63-80	7. Headache
79	60-95	63-80	8. Parkinsonism
80	60-95	73-80	O. Endocrine and Metabolism Disorders - symptomology, etiology, diagnostic tests
79	60-95	70-80	P. Hematology Disorders - symptomology, etiology, diagnostic tests
79	60-95	63-80	1. Anemias
78	60-95	63-80	a. Bone Marrow Failure
79	60-95	70-80	b. Megaloblastic
79	60-95	70-80	c. Iron Deficiency
79	60-95	70-80	d. Thalassemia
79	60-95	70-80	e. Anemia of Chronic Disease
79	60-95	70-80	f. Hemolytic

Median	Range	25th-75th Percentile	
79	60-95	70-80	2. Coagulation Disorders
79	60-95	70-80	a. Platelet Disorders
79	60-95	70-80	b. Coagulation Factors
79	60-95	70-80	c. Anemia of Chronic Disease
79	60-95	70-80	d. Hemolytic
79	60-95	70-80	1) Vitamin K Deficinecy, Coumarin Toxicity, Hepatboliary Disease
79	60-95	70-80	2) Hemophilia
79	60-65	70-80	3) Disseminated Intravascular Coagulation
78	60-95	70-80	3. Thrombosis
78	60-95	70-80	a. Pulmonary Embolus
78	60-95	70-80	b. Thrombophlebitis
78	60-95	65-80	4. Leukemias
79	60-95	65-80	Q. Oncology Disorders - symptomology, etiology, diagnostic tests
79	60-95	65-80	1. Lymphomas
79	60-95	65-80	a. Hodgkin's Disease
79	60-95	65-80	b. Reticulum Cell Sarcoma
79	60-95	65-80	2. Multiple Myeloma
79	60-95	65-80	3. Carcinoma of the Breast
79	60-95	65-80	4. Carcinoma of the Lung
79	60-95	65-80	5. Carcinoma of the Prostate
79	60-95	65-80	6. Gastrointestinal Cancer
79	60-95	65-80	7. Ovarian Carcinoma
79	60-95	65-80	8. Testicular Carcinoma

Median	Range	25th-75th Percentile	
79	60-95	65-80	9. Head & Neck Carcinoma
79	60-95	65-80	10. Malignant Melanoma
79	60-95	65-80	R. Human Behavior Disorders - symptomology, etiology, diagnostic tests
79	60-95	65-80	1. Schizophrenia
79	60-95	65-80	2. Depression
80	60-95	65-80	3. Organic Brain Syndrome
80	60-95	65-83	VIII. Human Nutrition
81	60-95	73-83	A. Protein, CHO and Fat
81	60-95	73-83	B. Energy
81	60-95	73-83	C. Clinical and Applied Human Nutrition
81	60-95	73-83	1. Endocrine Derangement (Diabetes)
81	60-95	73-83	2. Sodium and Potassium Restrictions
81	60-95	73-83	3. G-I Disease Problems
81	60-95	73-83	4. Hyperlipo-Proteinemia
81	60-95	73-83	5. Hyper lipidemia and Coronary Heart Disease
81	60-95	73-83	6. Vitamins
81	60-95	73-83	7. Drug-Food Interactions
81	60-95	73-83	D. Food Fads
82	26-95	70-90	IX. Health Science Terminology

Dosage Form Design

Median	Range	25th-75th Percentile	
20	0-51	13-40	I. Physiochemical Properties and Biological Activities
20	10-51	13-35	A. Intra and Intermolecular Interaction
20	10-41	13-40	1. Free energy change
20	10-41	13-40	2. Electron interactions (ion-ion, ion-dipole, ion induced dipole, dipole-dipole, dipole induced dipole, induced dipole-induced dipole, repulsion)
20	10-51	13-25	3. Van der Waal's force
20	10-51	13-25	4. Drug interactions
20	10-51	13-25	5. Force between molecules
20	10-51	13-25	6. Charge-separation
20	10-60	13-38	B. Debye Huckle's Equation
33	20-85	23-58	C. Solubility Effects
33	20-85	23-58	1. Acid-base
33	20-85	23-58	2. Mixed solvent
33	20-85	23-58	3. Temperature
33	20-85	23-58	4. Particle size
33	20-85	23-58	5. Crystalline form
16	10-55	10-28	D. Melting point and aqueous solubility of optical isomers
23	5-75	13-50	E. Interphasal transport of drug
23	5-75	15-50	1. Steady state transport
23	5-75	15-50	2. Passive transport
23	5-75	20-50	3. Fick's First Law of Diffusion
23	5-75	15-50	4. Partition coefficient
23	5-75	15-50	5. Facilitated transport

Median	Range	25th-75th Percentile		
43	5-85	20-55	F.	Dissolution rate (laminar, stagnant and turbulant flow) (Noyes-Whitney Equation)
20	15-75	20-38	G.	Chemical Decomposition
56	20-75	43-58	H.	Emulsions and Suspensions (Colloid structure, Gel structure and Micelle formation)
49	10-75	23-53	I.	Osmotic Pressure
49	10-75	23-53		1. Osmolarity
49	10-75	23-53		2. Osmole
41	10-55	17-50	J.	Micelle (Liquid Crystals)
41	10-55	17-50		1. Thixotropic (semetic, nematil, cholesters)
41	10-55	17-50		2. Lyotropic
41	10-55	17-50	K.	Protective Colloid (Donnan Equilibrium)
43	0-75	33-53	L.	Powdered Drug
43	10-75	33-53		1. Particle size distribution
43	5-75	33-53		2. Sedimentation velocity
43	5-75	33-53		3. Degree of flocculation
80	60-90	--	II.	Dosage Forms
61	40-95	53-78	A.	Suppository(rectal, vaginal, urethral) Bases (oleaginous, emulsion, water soluble)
63	50-95	53-73	B.	Ointments (Relationship of base/membrane to drug transport)
63	50-95	53-73		1. Oleaginous Bases
63	50-95	53-73		a. Animal fats or vegetable oils
63	0-95	50-73		b. Hydrocarbon (M.O., Petroleum, (Paraffin, Jelene)
63	50-95	53-73		c. Silicones
63	50-95	53-73		2. Absorption Bases
63	50-95	53-73		3. Emulsion Bases (o/w; w/o)
63	50-95	53-73		4. Water Soluble Bases

Median	Range	25th-75th Percentile	
58	20-95	50-75	C. Medicated Applications (Captaplasms, cements, cerates, creams, dressings, pastes, plaster, glycerogelations, glycentes)
80	60-95	--	D. Parenteral Products
81	60-95	70-85	1. Routes of administration (ID, SQ, IM, IV, Intra arterial, Intra cardiac, Intra articular, Intra synovial, Intra spinal, Intra thecal, Hypodemalysis)
79	60-95	75-83	2. Vehicles (water, others)
79	60-95	70-83	3. Sterility
78	60-95	75-83	4. Clarity
78	75-83	60-95	5. Pyrogenicity
78	60-95	70-83	6. Packaging
61	50-95	55-78	E. Powders (oral, dentrifrices, douche, dusting, insuffations, triturations)
61	50-95	55-78	1. Preparation
61	50-95	55-78	2. Special mixing problems (explosive mixture, eutectics)
61	55-95	60-78	F. Capsules (hard and soft gelatin)
61	55-95	60-78	1. Sizes
61	55-95	60-78	2. Filing procedures
61	55-95	58-70	G. Tablets
61	55-95	58-70	1. Molded (T.T, H.T., basic ingredients)
61	55-95	58-70	2. Compressed (Active ingredient, inert ingredients, diluents, binders, lubricants, disintegrators, colors and flavors)
61	55-95	58-70	3. Manufacture (Wet and dry dranulation, direct compression)
61	55-95	58-70	4. Characteristics (Hardness, thickness, weight, disintegration, dissolution)
61	55-95	58-70	5. Other (Buccal, sublingual, pellets, troches, cachets)

Median	Range	25th-75th Percentile	
61	55-98	58-70	6. Coating (Sugar, compression, film, enteric)
61	55-95	58-70	H. Microencapsulation
74	55-95	60-78	I. Prolonged Release Medications
59	55-90	--	J. Aerosols (Liquified gas, compressed gas)
60	5-90	53-65	1. Containers
59	5-90	35-65	2. Valves
63	40-90	--	K. Radiopharmaceuticals (Tc-99M, I_{131}, X_{133}, Zn_{111}k Tl^{201} , Thallium)
75	40-90	58-78	1. Nuclides (isotone, isobar, isotope)
75	40-90	67-78	2. Packaging
75	40-90	67-80	3. Dose measurement
78	40-95	75-83	4. Hot and cold scans
--	--	--	III. Dispensing
81	75-100	--	A. Laws and Ethics
90	75-100	78-100	1. Prescriptions (writing, validating, filing, labeling & recording keeping)
90	75-100	78-100	2. Storage temperatures USP
86	70-100	76-90	3. Container specifications
90	75-100	78-100	4. Expiration dating
90	75-100	78-100	5. Drug product selection
86	75-100	76-90	6. Pricing
80	70-100	76-90	B. Physical and chemical incompatibilities (Inorganic, organic)
83	75-100	80-100	C. Special packaging to facilitate administration
83	75-100	80-100	1. Needles and Syringes
83	75-100	80-100	2. Ophthalmic Medication (Sterility, clarity, tonicity, viscosity, pH and administration)

Median	Range	25th-75th Percentile		
83	75-100	80-100	3.	Otic Medications(Cerumen removal, vehicles)
83	75-100	80-100	4.	Nasal Medication (Vehicles, Administration)
83	75-100	80-100	5.	Rectal products
83	10-100	60-90	D.	Pharmaceutical Calculations
88	10-100	68-100	1.	Milliequivalents
83	10-100	75-100	2.	Milliosmoles
85	80-100	80-95	E.	Intravenous Solutions and Incompatibilities
85	80-100	80-88	1.	Vehicles
85	80-100	80-88	2.	Electrolytes
85	80-100	80-90	3.	Preparation
85	80-100	80-90	4.	Administration
85	80-100	80-88	5.	IV additives
85	80-100	80-90	6.	Reconstitution (K Pen G)
85	80-100	80-90	7.	Carbohydrate solutions (Dextrose, fructose, alcohol)
88	80-100	80-90	8.	Lactate
85	80-100	80-90	9.	Total parenteral nutrition
85	80-100	80-90	10.	Effect of light and temperature on stability
78	55-100	65-100	F.	Oral Liquid Medication Systems and Their Incompatibilities
78	55-100	65-100	1.	Emulsions
78	55-100	65-100	2.	Vehicles (water, aromatic water, syrups, alcoholic)
70	50-100	--	G.	Powder Incompatibilities
70	50-100	63-70	1.	Deliquescent
70	50-100	63-70	2.	Efflorescent

Median	Range	25th-75th Percentile		
70	50-100	63-70		3. Eutectic
70	50-100	63-70		4. Volatile sustance
70	50-100	63-70		5. Explosive
70	60-100	--	H.	Ointment Incompatibilities
70	60-100	63-73		1. Levigating agents
70	60-100	63-73		2. Crystalline salts
70	60-100	63-73		3. Alcoholic liquids
69	50-100	60-73		4. Tars
69	50-100	60-73		5. Peruvian balsam
71	60-100	63-78		6. Ointment - medicament reactions
61	60-100	60-73	I.	Lotion Compounding incompatibilities
61	60-100	60-63		1. Suspensions (Shake lotions)
61	60-100	60-63		2. Oil containing (Lime water)
61	60-100	60-63	J.	Collodion Compounding Incompatibilities
60	0-100	60-60		1. Excessive solutes
83	65-100	--	IV.	Biopharmaceutics
84	65-100	80-88		A. Methods of comparing rate and extent of bioavailability of drug products
84	65-100	80-88		1. Blood level
84	65-100	80-88		2. Urinary excretion
84	65-100	80-88		3. In Vitro dissolution
84	65-100	80-88		B. Equivalence
84	65-100	80-88		1. Chemical
84	65-100	80-88		2. Biological
84	65-100	80-88		3. Therapeutic
84	65-100	80-88		4. Absolute and relative bioavailability

Median	Range	25th-75th Percentile	
84	65-100	80-88	5. Interpretations of blood or plasma data
83	65-100	73-88	C. Prolonged Action Dosage Forms (delayed, repeat, sustained)
89	65-100	80-93	D. Route of administration effects
89	65-100	80-90	E. Physiologic variables
90	65-100	83-95	F. Clinical variables (disease, food)
86	65-100	80-90	G. Product selection criteria
--	--	--	V. Pharmacokinetics
77	70-100	73-85	A. Basic concepts
77	70-100	75-85	1. First Order Elimination (half-life and biological half-life)
77	70-100	75-85	2. Volume of Distribution
77	70-100	75-85	3. Clearance
77	70-100	75-85	4. Total body clearance
78	70-100	--	B. Absorption variables
78	70-100	--	1. Membrane Transport
78	50-100	70-90	a. Passive diffusion
78	40-100	70-90	b. Selectivity property
78	40-100	70-90	c. Active transport
78	30-100	70-90	d. Pinocytosis
78	50-100	70-90	e. Dialysis
80	70-100	73-90	2. Gastric emptying
80	70-100	73-90	3. Transit times
80	70-100	73-90	4. Metabolism during absorptive phase
78	70-100	75-90	C. Protein binding
78	60-100	70-90	1. Drug interaction
78	20-100	70-90	2. Thermodynamic approach

Median	Range	25th-75th Percentile	
78	30-100	70-90	3. Site binding
78	30-100	70-90	4. Competitive binding
78	30-100	70-90	5. Non-competitive binding
78	70-100	75-90	D. Biotransformation
78	70-100	73-90-	1. Liver, intestinal mucosa, lung, kidney
78	70-100	73-90	2. Rate and extent factors
78	70-100	75-88	3. First pass effect
78	60-100	73-88	4. Pathways
78	60-100	73-88	a. Microsomal reactions
78	60-100	73-88	b. Non-microsomal oxidations
78	60-100	73-88	c. Miscellaneous reductions
78	60-100	73-88	5. Drug conjugation pathways
83	70-100	75-90	6. Enzyme induction
76	70-100	--	E. Elimination - the loss of drug from the body
83	70-100	75-90	1. Renal excretion
83	70-100	75-90	a. Glomerular filtration
83	70-100	75-90	b. Secretion
83	70-100	75-90	c. Tubular reabsorption
78	50-100	73-88	2. Biliary excretion of drugs
80	70-100	75-88	F. Kinetics following single oral dose (drug pathways)
80	70-100	75-90	G. Excretion kinetics
81	70-100	75-88	H. Kinetics during constant rate infusion
80	10-100	73-88	1. Plateau principle (average, magnitude and rate)
81	70-100	75-88	2. Loading dose plus constant rate infusion

Median	Range	25th-75th Percentile		
89	70-100	78-90	I.	Multiple Dosing Regimens and Plasma Concentrations
89	70-100	78-90		1. Multiple IV doses - constant interval
89	70-100	78-90		2. Loading dose plus regular maintenance
89	70-100	78-90		3. Drug acculation
90	70-100	80-93	J.	Dosage Regimens by Age & Disease States
90	70-100	80-93		1. Half-life
90	70-100	80-93		2. Volume of Distribution
90	70-100	80-93		3. Drug Metabolism
90	70-100	80-93		4. Renal function
90	55-100	78-93		5. Pediatrics and Geriatrics
75	55-100	68-93	K.	Kinetics of Pharmacologic Response
75	55-100	68-93		1. Law of Mass Action
75	55-100	68-93		2. Duration of response
93	76-100	85-95	L.	Pharmacokinetics Parameters of Specific drug classes and drugs
93	76-100	8[illegible]-95		1. Selected Antibiotics (Penicillins, Aminoglycosides, Tetracyclines, ephalosporins)
93	76-100	85-95		2. Selected Cardiovascular agents (Digitalis, quinidine, procainamide, lidocaine, propranolol)
90	75-100	78-95	M.	Drug Interaction Kinetics
93	80-100	90-95	N.	Dosage Regimen Optimization
94	80-100	90-95		1. Use of patient variables to estimate initial dose
93	80-100	90-95		2. Use of blood levels to determine patient parameters
93	80-100	90-95		3. Use of model to determine optimum dose
93	80-100	85-95		4. Computer methods for pharmacokinetics

DRUG ACTION

Median	Range	25th-75th Percentile		
54	51-100	--	I.	Drug Nomenclature and Classification
80	51-100	55-90		A. Names (chemical, non-proprietary (USAN), and proprietary or trade names.
80	51-100	55-88		B. Classification (level of interaction with organism, and primary or useful effect)
68	65-100	--	II.	Drug Action by Therapeutic Use
68	65-100	--		A. Anesthetic Agents
78	60-100	65-85		1. Classification by level of action
75	60-100	65-83		a. general anesthetic agents (ether, cyclopropane, ethylene, fluothane, ketamine, pentathol)
75	60-100	65-83		b. local anesthetic agents (procaine, lidocaine, xylocaine)
79	65-100	75-83		2. Routes of administration
75	55-100	63-83		3. Physiological theory of anesthesia
75	65-100	65-83		4. Pharmacodynamic mechanisms
75	65-100	68-83		5. Toxicodynamic mechanisms
75	65-100	68-83		6. Pharmacological effects
79	65-100	70-83		7. Side effects and toxicology
80	65-100	70-83		8. Indications and contraindications
76	65-100	68-83		9. ADME (Absorption, distribution, metabolism, excretion)
80	65-100	70-83		10. General anesthetic adjuncts
83	65-100	70-85		11. Drug interactions
78	70-100	--		B. Sedative-Hypnotic Agents
80	55-100	73-88		1. Chemical classifications

Median	Range	25th-75th Percentile	
80	55-100	73-88	a. barbiturates
80	55-100	73-88	b. non-barbiturates (alcohol, chloral, ethchlorvynol, meprobromate, methyprylon, gluthetamide, methaqalone, benzodiazepines)
80	55-100	73-90	2. Physiological theory of sleeping cycle
80	70-100	73-88	3. Pharmacodynamic mechanisms
79	70-100	73-83	4. Toxicodynamic mechanisms
79	70-100	73-83	5. Pharmacological effects
81	70-100	78-88	6. Side effects and toxicology
81	70-100	78-88	7. Indications and contraindications
80	70-100	75-85	8. ADME
81	70-100	75-85	9. Tolerance
83	70-100	75-88	10. Intoxication
73	70-100	--	C. Anticonvulsants
76	55-100	--	1. Chemical classifications
78	55-100	73-85	a. barbiturates (Phenobarbital, mephobarbital and metharbital)
78	55-100	75-85	b. non barbiturates (phenytoin, trimethadione, ethosuximide)
78	55-100	65-85	2. Physiological theory of convulsion
78	70-100	73-90	3. Pharmacodynamic mechanisms
83	70-100	73-85	4. Toxicodynamic mechanisms
86	70-100	73-90	5. Pharmacological effects
84	70-100	75-90	6. Side effects and toxicology
88	70-100	75-95	7. Indications and contraindications
84	70-100	75-88	8. ADME

Median	Range	25th-75th Percentile	
85	70-100	78-90	9. Drug interactions
75	75-100	--	D. Neuroleptic Agents (phenothiazines, tricyclics, butyrophenones, lithium)
76	58-100	70-80	1. Chemical classifications--structure-activity relationships
81	75-100	80-88	2. Symptoms classification
81	75-100	78-88	a. anxiety
81	75-100	80-88	b. psychotic
81	75-100	80-88	c. depression
79	55-100	75-[illegible]	3. Physiological theory of psychological disorders
80	70-100	75-8[illegible]	4. Pharmacodynamic mechanisms
80	70-100	75-85	5. Toxicodynamic mechanisms
81	75-100	75-85	6. Dose dependent pharmacological profile
81	75-100	75-90	7. Side effects and toxicology
81	75-100	78-90	8. Indications and contraindications
80	75-100	75-88	9. ADME
81	75-100	75-88	10. Tolerance, dependence
81	50-100	75-90	11. Social, cultural, psychological basis of drug dependence
76	75-100	--	E. Antiparkinsonism Agents (Levodopa)
78	55-100	75-85	1. Physiological theory of parkinsonism
78	70-100	75-88	2. Pharmacodynamic mechanisms
78	60-100	75-88	3. Pharmacological effects
83	75-100	75-88	4. Side effects and toxicology
83	75-100	75-88	5. Indications and contraindications
84	75-100	75-88	6. Drug interactions

Median	Range	25th-75th Percentile	
68	30-100	--	F. Central Muscle Relaxants (mephenosin, meprobomate)
74	30-100	60-78	1. Chemical classification--SAR
74	30-100	68-78	2. Pharmacodynamic mechanisms
76	30-100	63-90	3. Pharmacological effects
76	30-100	68-85	4. Side effects and toxicology
78	30-100	68-85	5. Indication and contraindications
75	30-100	68-80	6. ADME
66	55-100	--	G. Analeptics (strychnine, picrotoxin, nikethamide, xanthines, methylphenidate, MAOI, thymoleptics, neuroleptics, hallucinogens)
75	55-100	60-76	1. Chemical classification
75	55-100	60-76	2. Physiological theory of CNS stimulation
75	55-100	68-78	3. Pharmacodynamic mechanisms
75	55-100	68-80	4. Toxicological mechanisms
75	55-100	63-83	5. Pharmacological effects
76	55-100	70-85	6. Side effects and toxicology
77	55-100	70-85	7. Indication and contraindications
77	55-100	70-88	8. Drug interactions
78	70-100	--	H. Analgesics
83	55-100	73-85	1. Chemical classification--SAR
83	55-100	73-85	a. opiates (morphine, meperidine)
83	55-100	73-85	b. endorphins
83	55-100	73-85	2. Pharmacodynamic mechanisms
80	70-100	73-85	3. Toxicological mechanisms
83	70-100	73-88	4. Pharmacological effects

Median	Range	25th-75th Percentile	
83	60-100	73-88	5. Side effects and toxicology
83	70-100	75-80	6. Indication and contraindications
83	0-100	73-90	7. Drug interactions
83	70-100	78-85	a. antagonists (nalorphine, levollorphan
83	70-100	78-85	b. partial agonists
75	75-100	--	I. Nonsteroidal Antiinflammatory Agents (salicylates, pyrazolones, antipyrine, phenylbutazone, indomethacin, mefenamic acid, ibuprofen, gold, antimalarials, colchicine, allopurinol)
77	55-100	75-83	1. Chemical classifications
80	55-100	75-85	2. Physiological theory of inflammation
80	70-100	75-85	3. Pharmacodynamic mechanisms
83	60-100	75-90	4. Pharmacologic effects
83	75-100	75-90	5. Side effects and toxicology
83	75-100	78-90	6. Indications and contraindications
83	75-100	75-85	7. ADME
75	75-100	--	J. Autonomic Agents
78	55-100	75-95	1. Chemical transmitter classification
78	55-100	75-95	a. adrenergic
78	55-100	75-95	b. cholinergic
78	65-100	75-95	2. Pharmacologic classification
78	65-100	75-95	a. adrenergic agents
78	65-100	75-95	b. adrenergic blocking agents
78	65-100	75-95	1) α-receptor blocking agents (phenoxybenzamine, ergot, tolazoline, azapetine)
78	65-100	75-95	2) β_1, β_2 - receptor blocking agents (propranolol)

Median	Range	25th-75th Percentile	
83	65-100	75-95	3) pre-synaptic receptor blocking agents
83	65-100	75-95	4) synthesis, storage, release of adrenergic transmitter blocking agents
83	65-100	75-95	c. cholinergic agents (carbachol, muscarine)
83	65-100	75-95	d. cholinergic blocking agents
83	65-100	75-95	1) cholinergic antagonist (atropine, scopolamine)
83	65-100	75-95	2) anticholinesterase (physostigmine, neostigmine)
83	55-100	75-95	3) ganglionic blocking agents (hexamethonium)
83	55-100	75-95	4) neuromuscular junction blocking agents (d-tubocurare, succinylcholine)
83	55-100	75-93	3. Physiological basis of autonomic nerve and chemical transmitters
78	55-100	75-90	4. SAR
83	70-100	75-95	5. Pharmacodynamic mechanisms
83	70-100	75-93	6. Toxicodynamic mechanisms
85	60-100	75-95	7. Pharmacologic effects
85	75-100	75-95	8. Side effects and toxicology
85	75-100	78-90	9. Indications and contraindications
83	75-100	75-90	10. ADME
86	75-100	78-93	11. Drug interactions
75	65-100	--	K. Histamine and Antihistamines
78	55-100	70-88	1. Classification
78	55-100	70-88	a. H_1 receptor blocking agents (diphenhydramine, tripelennamine)

Median	Range	25th-75th Percentile	
78	55-100	70-88	b. H_2 receptor blocking agents (cimetadine)
78	55-100	70-88	2. SAR
78	65-100	73-88	3. Pharmacodynamic mechanisms
78	60-100	70-88	4. Pharmacologic effects
83	65-100	75-88	5. Side effects and toxicology
83	65-100	75-88	6. Indications and contraindications
78	65-100	75-85	7. ADME
78	75-100	--	L. Diuretics
83	60-100	75-90	1. Pharmacological classifications
85	75-100	75-95	a. osmatic (polyols, sugars, urea)
83	60-100	75-90	b. acid-forming (ammonium chloride, nitrate)
83	60-100	75-90	c. mercurial
83	60-100	75-90	d. sulfonamide (carbonic anhydrase inhibitors)
83	60-100	75-90	e. potassium retaining (spirono-lactone)
83	60-100	75-90	f. thiazides (chlorothiazide)
83	60-100	75-90	g. other (ethyacrynic acid & furosemide)
83	70-100	75-88	2. Pharmacodynamic mechanisms
83	60-100	75-90	3. Pharmacological effects
83	75-100	75-90	4. Side effects
83	75-100	78-90	5. Indications and contraindications
84	75-100	78-85	6. Refractory effects of diuretics--tolerance
84	75-100	78-90	7. Drug interactions

Median	Range	25th-75th Percentile	
78	75-100	--	M. Antihypertensives
83	60-100	75-88	1. Pharmacological classification
83	60-100	75-88	a. diuretics (hydrochlorothiazide)
83	60-100	75-88	b. vasodilators (hydralazine)
83	60-100	75-88	c. adrenergic blocking agents (reserpine, methyldopa, propranolol)
83	60-100	75-88	d. others
83	55-100	75-88	2. Physiological basis of hypertension
83	70-100	75-88	3. Pharmacodynamic mechanisms
83	70-100	75-90	4. Toxicodynamic mechanisms
83	60-100	75-90	5. Pharmacological effects
83	75-100	75-90	6. Side effects and toxicology
83	75-100	78-90	7. Indications and contraindications
84	75-100	78-90	8. Drug interactions
78	75-100	--	N. Antiarrhythmic Agents (quinidine, lidocaine, propranolol)
83	55-100	75-85	1. Chemical classification--SAR
84	55-100	75-88	2. Physiological basis of arrhymthia
84	70-100	75-88	3. Pharmacodynamic mechanisms
84	60-100	75-88	4. Pharmacological effects
84	75-100	75-88	5. Side effects and toxicology
84	75-100	78-88	6. Indications and contraindications
84	75-100	--	O. Antianginal Agents (nitrites, dipyridamole, propranolol, slow channel blockers, lipid lowering agents)
84	60-100	75-88	1. Pharmacological classification
84	55-100	75-88	2. Physiological basis of angina pectoris

Median	Range	25th-75th Percentile	
84	70-100	75-88	3. Pharmacodynamic mechanisms
84	60-100	75-88	4. Pharmacological effects
84	75-100	75-88	5. Side effects and toxicology
84	75-100	78-88	6. Indications and contraindications
75	75-100	--	P. Cardiac Glycosides
77	55-100	75-88	1. Chemical classification--SAR
77	55-100	75-90	2. Physiological basis of congestive heart failure
77	70-100	75-88	3. Pharmacodynamic mechanisms
77	70-100	75-88	4. Toxicodynamic mechanisms
77	60-100	75-90	5. Pharmacological effects
81	75-100	75-93	6. Side effects and toxicology
81	75-100	76-93	7. Indications and contraindications
85	75-100	76-90	8. Drug interactions
76	70-100	--	Q. Clotting Mechanism and Fluid Volume Agents
76	55-100	--	1. Classification
77	55-100	73-81	a. blood products (whole cell, plasma fractions)
77	55-100	73-86	b. anticoagulants (heparin, coumadin, protamine)
77	55-100	73-84	c. plasma extenders (dextran, PVP, salt solutions)
77	70-100	73-86	2. Pharmacodynamic mechanisms (coagulation factors and cascade)
77	70-100	73-86	3. Toxicodynamic mechanisms
77	60-100	73-86	4. Pharmacologic effects
80	70-100	75-86	5. Side effects and toxicology

Median	Range	25th-75th Percentile	
80	70-100	76-86	6. Indications and contraindications
83	70-100	78-90	7. Drug interactions
90	70-100	--	R. Endocrine Agents
78	55-100	--	1. Classification
78	55-100	70-88	a. anterior pituitary (GH, ACTH, TSH, MSH, FSH, LH)
78	55-100	70-88	b. posterior pituitary (oxytocin, vasopressin)
78	55-100	70-88	c. gonadotropic (placental) (human chorionic and placental lactogen and relaxin)
78	55-100	73-80	d. steroid (progestins, estrogens, androgens, chemical contraceptines, ovulation stimulants)
83	55-100	73-90	e. thyroid (monoiodotyrosine, iodide, propylthiouracil)
78	55-100	73-88	f. pancreatic (insulin, glucagon, oral antidiabetics)
83	55-100	73-88	g. calcium (parathyroid, calcitonin)
83	55-100	73-88	h. adrenal (cortisol, androgens, mineral, corticoids, norepinephrine, dopamine)
78	55-100	70-88	i. hypothalmic regulatory (release and inhibitory factors)
83	70-100	73-90	2. Metabolic pharmacodynamic mechanisms
83	70-100	73-90	a. releasing factors
83	70-100	73-90	b. release regulation
85	70-100	73-90	3. Toxicodynamic mechanisms
85	60-100	73-90	4. Pharmacologic effects
85	70-100	75-90	5. Side effects and toxicology

Median	Range	25th-75th Percentile	
85	75-100	78-90	6. Indications and contraindications
86	75-100	80-90	7. Drug interactions
83	75-100	--	S. Vitamins
78	55-100	75-88	1. Classification
78	55-100	75-88	a. fat soluble (ADKE)
78	55-100	75-88	b. water soluble (B_1, B_2, B_3, B_4, B_6, B_{12}, B_{15}, folic acid, biotin)
78	55-100	75-88	c. Laetrile
78	70-100	75-88	2. Toxicodynamic mechanisms
78	70-100	75-88	3. Pharmacologic effects
80	75-100	75-88	4. Side effects and toxicity
81	75-100	75-88	5. Indications and contraindications
80	55-100	75-88	6. Recommended daily allowance
78	50-100	--	7. Sources
76	65-100	--	T. Enzymes and Proteins
75	55-100	--	1. Classification
75	55-100	70-78	a. digestive (gastric, pancreatic, carbohydrate)
75	55-100	68-78	b. therapeutic (penicillinase, hyaluronidase)
75	55-100	68-78	c. debridement (fibrinolinase, papain)
75	65-100	73-78	2. Pharmacodynamic mechanisms
75	65-100	73-78	3. Toxicodynamic mechanisms
75	60-100	70-78	4. Pharmacologic effects
77	65-100	75-80	5. Indications and contraindications
83	60-100	--	U. Respiratory Tract Drugs

Median	Range	25th-75th Percentile	
80	55-100	68-88	1. Classification
80	55-100	68-88	a. decongestants (phenylephrine)
80	55-100	68-88	b. bronchodilators (adrenergic and xanthine)
80	55-100	68-88	c. antitussives (narcotic and non-narcotic)
80	55-100	68-88	d. expectorant (stimulant and sedative)
80	55-100	68-88	e. mucolytic
80	55-100	68-88	f. respiratory stimulants (CO_2, picrotoxin)
80	55-100	68-88	2. Pharmacodynamic mechanisms
80	60-100	73-88	3. Toxicodynamic mechanisms
80	60-100	73-88	4. Pharmacologic effects
81	60-100	78-88	5. Indications and contraindications
81	60-100	78-88	6. Side effects and toxicology
83	60-100	78-88	7. Drug interactions
70	55-100	--	V. Diagnostic Agents
73	55-100	60-83	1. Classification
73	55-100	60-83	a. radiopaque substances (barium sulfate, iopanoic acid)
73	55-100	60-83	b. radiopharmaceuticals (Tc99M, I_{131}, X_{133}, ZN_{111}, Tl_{201})
73	55-100	68-83	2. Pharmacodynamic mechanisms
73	55-100	68-83	3. Toxicodynamic mechanisms
73	55-100	68-83	4. Pharmacologic effects
79	55-100	68-83	5. Indications and contraindications
78	58-100	68-83	6. Side effects and toxicology

Median	Range	25th-75th Percentile	
76	65-100	--	W. Immunizing Biologicals
76	55-100	--	1. Classification
76	55-100	70-85	a. vaccines
76	55-100	70-85	b. toxoids
76	55-100	70-85	c. antitoxins (antisera, human serum globulin)
76	55-100	70-85	d. diagnostic (diphtheria, tuberculin)
76	65-100	73-85	2. Pharmacodynamic mechanisms
76	65-100	73-85	3. Toxicodynamic mechanisms
77	65-100	75-85	4. Indications and contraindications
77	65-100	75-85	5. Side effects and toxicology
78	55-100	--	X. Chemotherapy
85	55-100	65-90	1. Classification
85	55-100	65-90	a. antiparasite (antimalarials, amoebasis, antiprotozoans, anthelminthics)
85	55-100	65-90	b. antifungal
85	55-100	65-90	c. pesticides (pyrethrum)
85	55-100	65-90	d. antiviral (idoxuridine)
85	55-100	65-90	e. antimicrobial (penicillin, tetracycline, antibiotics, sulfonamides)
85	55-100	65-90	f. antimycobacterial (streptomycin, cycloserine, sulfones, ethambutol)
85	55-100	65-90	g. antiseptics and disinfectants (phenol, alcohol, iodine, chlorine, mercurids)
85	55-100	65-90	h. antineoplastic (cytoxan, ara C, Velbar, mitracin, hydrea)

Median	Range	25th-75th Percentile	
85	55-100	73-90	2. Pharmacodynamic mechanisms
85	55-100	73-90	3. Toxicodynamic mechanisms
85	55-100	68-93	4. Pharmacologic effects
85	55-100	78-93	5. Indications and contraindications
85	55-100	75-93	6. Side effects and toxicology
86	55-100	78-90	7. Drug interactions
86	55-100	78-90	8. Sensitivity testing and resistance
95	80-100	--	III. Therapeutics, monitoring for efficacy, and patient education for major diseases
95	80-100	88-100	A. Cardiovascular Disease
95	80-100	88-100	1. Hypertension
94	80-100	88-98	2. Congestive Heart Failure
95	80-100	88-100	3. Ischemic Heart Disease
95	80-100	88-100	4. Cardiac Arrythmias
93	80-100	--	B. Metabolic Disorders
93	80-100	85-98	1. Thyroid
93	80-100	83-98	2. Adrenal Cortex
93	80-100	90-98	3. Diabetes Mellitus
93	75-100	78-98	4. Others (Tay-Sachs, PKU, etc.)
95	80-100	85-98	C. Clinical Toxicology (Poisoning)
90	80-100	80-98	D. Hematology
93	80-100	80-98	1. Anemias
93	80-100	80-100	2. Anticoagulants
88	70-100	83-98	E. Fluid and Electrolyte Balance
94	80-100	85-98	F. Renal Disease and Urinary Tract Infections

Median	Range	25th-75th Percentile		
93	80-100	83-98		G. Pulmonary Disease
93	80-100	83-98		H. Psychiatric Disorders
94	80-100	85-98		I. Headache
93	80-100	83-98		J. Rheumatoid Arthritis and Gout
93	80-100	80-98		K. Ocular Diseases
94	80-100	88-98		L. Infectious Diseases
91	80-100	85-98		M. Gastrointestinal Disease
93	80-100	85-98		N. Liver Disease
98	80-100	93-100	IV.	Drug Use in Self Limiting Illnesses
98	80-100	93-100		A. Triage Decision Trees (Symptoms, age, duration, other symptoms, past medical and drug history and treatment)
98	80-100	93-100		B. Symptomotology
98	80-100	93-100		1. Coughs/Cold/Asthma
98	80-100	93-100		2. Systemic pain/menstrual medications
98	80-100	93-100		3. Diarrhea/constipation/emetics/ ostomy care
98	80-100	93-100		4. Vitamins/weight control/infant formulas
98	80-100	93-100		5. External parasites/contraception/ Feminine cleansing
98	80-100	93-100		6. Antacids/hemorrhoidal preparations/ dental
98	80-100	92-100		7. Sleep aids/ophthalmics/stimulants/ otic
98	80-100	93-100		8. Acne/burn/topical/and systemic analgesics
98	80-100	93-100		9. Eczema/psoriasis/antiseborrheia/ topical antiinfectives

Median	Range	25th-75th Percentile	
98	80-100	93-100	10. Diaper rash/prickly heat/corn/ callus/wart
98	80-100	93-100	11. Athletes foot/insect bites/ poison ivy

Provision or Delivery of Pharmaceutical Services

Median	Range	25th-75th Percentile	
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75	35-85	47-78	A. Health Care Institutions
76	35-85	65-80	1. Hospitals
76	35-85	65-80	a. inpatient areas
76	35-85	65-80	b. outpatient clinical pharmacies
76	0-90	48-80	2. Community Pharmacies
71	35-85	48-78	3. Ambulatory Facilities
71	35-85	48-78	a. family practice clinic
71	35-85	48-78	b. private group practice
71	35-85	48-78	c. HMO
71	35-85	48-78	d. surgicenters
71	35-85	60-76	4. Long Term Care
76	35-85	48-78	a. nursing home
71	35-85	48-78	b. board and care house
51	26-80	28-73	B. Health Manpower (Types, Education, Deployment and Specialization)
77	40-90	50-79	C. Reimbursement Issues (Third Party and HMOs)
66	30-90	40-78	D. Federal Government (Health Legislation, Social Security, Title 18, Title 19 and Quality Control)
52	1-80	28-70	E. State and Local Government
31	10-80	23-48	F. History of U.S. Pharmacy
51	30-80	45-60	G. Professional Organizations in Pharmacy
67	30-80	45-73	H. National Health Insurance

Median	Range	25th-75th Percentile		
66	35-80	45-76	I.	Malpractice
65	30-80	45-76	J.	Consumerism
76	30-85	48-80	K.	Preventive Medicine
61	25-80	35-76	L.	Pharmaceutical Industry (Manufacturing, Wholesaling and Retail)
50	20-80	23-55	M.	International Pharmacy
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51	30-95	50-76	A.	Social Science in Pharmacy (Socialization, Professionalism, Relationships between Education and Practice, Intra and Interprofessional Interactions)
76	0-95	43-78	B.	Behavior in Illness and in Health
76	35-95	63-80		1. The Sick Role
76	35-95	63-80		a. concepts of disease (biological and social deviance)
76	35-95	63-80		b. values, attitudes, beliefs
76	35-95	63-80		2. The Health Belief Model
76	35-95	63-80		3. Health Care Utilization
76	35-95	63-80		4. The Lay Referral System
76	35-95	62-80		5. Professional Referral System
86	35-95	80-90	C.	Compliance and Patient Education
88	35-95	80-90		1. Socio-Behavior Determinants of Compliance
86	35-95	55-90		2. Life Style and Health Status
85	35-95	76-90		a. factors that affect health
86	35-45	80-90		b. measurements of health status
88	35-95	80-93		3. Patient Education Planning

Median	Range	25th-75th Percentile		
86	35-95	73-90		4. Behavioral Aspects of Rational Drug Therapy
86	35-95	78-90		5. The Patient Package Insert (function as viewed by PMA, APhA, Consumer, FDA)
88	35-95	80-90		6. Confidentiality in the Patient Pharmacist Interaction (counseling, record keeping)
76	35-95	70-83		D. The Management of Psychomatic Determinants and Pain
76	35-95	70-83		1. Psych-Social and Cultural Determinants
76	35-95	70-83		2. Psychosomatic Disorders
76	35-95	70-83		3. Placebo Effects
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78	60-95	70-80		A. Functions of Management
75	60-95	70-80		B. Psychology of Pharmacy Management
75	60-95	70-80		1. Team Management Skills (motivating, facilitating, group dynamics, group organization, leadership and management styles)
63	40-95	55-78		C. Economic Concepts (Supply, Demand, Elasticity, Types of Competition)
78	70-95	70-80		D. Organization of a Pharmacy Practice
78	70-95	70-80		1. Organizational Concepts (structures, group practice, legal)
75	40-95	55-80		E. Financial Management
75	40-95	55-80		1. Financial Statements (balance sheet and profit and loss)
75	40-95	55-80		2. Financial Ratio Analysis
75	40-95	55-80		3. Depreciation

Median	Range	25th-75th Percentile		
75	40-95	55-80		4. Cash Flow
78	50-95	75-80	F.	Inventory Control and Purchasing (Sources of Supply, Return Goods Policy, Selecting Merchandise, Inventory Levels and Discounts)
75	60-95	75-80	G.	Pricing and Price Policies
78	60-95	75-80	H.	Pharmacy Practice Management (Location, Layout, Modernization)
79	60-95	68-80	I.	Policies and Procedures
75	40-95	45-80	J.	Risk Management
78	40-95	55-80	K.	Promotion
76	40-95	55-80		1. Personnel Selling
76	40-95	55-80		2. Advertising
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85	80-100	80-90	A.	Vital Signs Evaluation
86	80-100	83-90	B.	Cardiopulmonary Arrest (MI, Asthma, Hemorrhage, Shock)
85	60-100	75-90	C.	Fractures and Wounds
85	60-100	78-90	D.	Psychological Diseases
86	80-100	80-90	E.	Toxicology
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86	50-95	85-93	A.	Drug Information Retrieval
86	50-95	83-93		1. Indexing Services
86	50-95	83-93		2. Serial Periodicals
86	50-95	83-93		3. Foreign Language Literature
86	50-95	83-93		4. Current Medical Literature
86	50-95	83-93		5. Abstracting Services

Median	Range	25th-75th Percentile		
85	76-95	80-85	B.	Clinical Research Evaluation
85	76-95	80-85		1. Random Sample or Allocation
85	76-95	80-85		2. Hard and Soft Data
85	76-95	80-85		3. Hierarchical Research Methodologies
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85	70-98	73-88		A. Nature and Problems of Old Age-Characteristics
85	70-98	73-88		1. Socio-Demographic
85	70-98	73-88		2. Health Status and Utilization of Health Care
85	70-98	73-88		3. Emotional Problems
85	70-98	73-83		4. Functional Disorders
85	70-98	73-83		5. Family
85	70-98	73-88		6. Special Concerns (Alcoholism, Sexuality)
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83	40-95	68-85		1. Diagnostic Evaluation (housing, transportation, nutrition, health)
83	40-95	73-85		2. General Treatment Principles
83	40-95	68-85		3. Independent Living
83	40-95	68-85		4. Proper Institutional Care
83	40-95	68-85		5. Psychotherapy and Environmental Therapy
68	60-94	68-88		6. Drug Therapy and the Elderly
85	60-95	78-88		a. drug consumption - OTC and Rx
85	60-95	78-88		b. adverse reactions
86	60-95	78-93		c. self-medication

Median	Range	25th-75th Percentile		
86	60-95	78-90		d. drugs which influence behavior
84	60-95	78-88		e. alcohol
84	60-95	78-88		f. addiction and treatment
86	60-95	78-90		g. pharmacokinetics and aging
76	50-95	50-83		C. Society of the Elderly (Organizations, Governmental Programs)
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74	40-85	53-75		A. Social Organization of Death
74	40-85	53-75		1. Functionaries Involved with Death; Dying (physician, nurse, pharmacist, coroner, funeral director, morgue attendent and mortician)
74	40-85	53-75		2. Institutions Involved (hospital, hospice and nursing home)
68	40-80	40-75		B. Cross Cultural Meaning of Death (Race, Age, Ethnicity and Religion)
68	40-80	40-75		C. Death of Self
73	40-80	40-75		D. Fear of Death
75	40-95	50-78		E. Communication (Dying Patient, Survivors)
75	40-85	53-78		F. Psychological Factors (Fear, Loss, Denial, Anger and Hostility)
75	40-85	40-78		G. Lethal Behavior and Psychological Intervention
75	40-85	40-75		H. Current Ethical Issues (Euthanasia and Prolongation of Life)

ADDENDUM III

INTERRELATIONSHIPS BETWEEN BASIC PHARMACEUTICAL SCIENCE AREAS AND CLINICAL PHARMACY PRACTICE FUNCTIONS WITH RATIONALE

FUNDAMENTAL BACKGROUND AREAS

Basic Science Area	Clinical Pharmacy Practice Functions	Rationale
I. Mathematical	Drug produce evaluation. Drug therapy design and evaluation. Drug administration. Selection and assessment of non-drug therapy. Drug Information retrieval. Pharmacy systems management and economics.	Essential biological or physical science application. Biological or physical science application. Other common area of input for clinical pharmacy permits exploitation of function. Skill practice for function. Content area for function. Behavioral science application.
II. Physical Chemistry	Drug product evaluation. Design, administration and monitoring or intravenous therapy.	Essential biological or physical science precursor.
III. Pharmaceutical Analytical Chemistry	Drug product evaluation. Drug therapy design and evaluation Design, administration and monitoring of intravenous therapy Poisoning identification and treatment	Essential biological or physical science precursor. Biological or physical science application. Content area for clinical function. Permits exploitation of function Skill practice for function.
IV. Biological Chemistry	Drug therapy design and evaluation Drug product evaluation. Design, administration and monitoring of intravenous therapy. Emergency care treatment and assessment. Drug administration.	Essential biological or physical science precursor. Content are for clinical function. Permits exploitation of function Biological or physical science application.
V. Microbiology	Drug therapy design and evaluation. Drug product evaluation. Design, administration and monitoring of intravenous therapy.	Essential biological or physical science precursor. Content area for clinical function. Biological or physical science application. Permits exploitation of function

Basic Science	Clinical Pharmacy Practice Functions	Rationale
VI. General Pharmacological Principles	Drug product evaluation Drug therapy design and evaluation. Poisoning identification and treatment. Drug administration. Drug information retrieval. Communications in the health care setting. Emergency care treatment and assessment. Selection and assessment of non-drug therapy.	Content area for clinical function. Permits exploitation of function Skill practice for function. Essential biological of physical science precursor. Biological or physical science application.
VII. Physiology and Pathophysiology	Drug therapy design and evaluation. Drug product evaluation. Poisoning identification and treatment. Emergency care treatment and assessment. Design, administration monitoring of intravenous therapy. Selection and assessment of non-drug therapy. Drug administration.	Essential biological or physical science precursor. Content area for clinical function. Biological or physical science application.
VIII. Human Nutrition	Design, administration and monitoring of intravenous therapy. Drug therapy design and evaluation. Communications in the health care setting. Poisoning identification and treatment. Emergency are treatment and assessment. Selection of assessment of non-drug therapy. Drug administration.	Essential biological or physical science precursor. Content area for clinical function. Biological physical science application. Permits exploitation of function. Behavioral science application.
IX. Health Science Terminology	Drug therapy design and evaluation. Communications in the health care setting. Drug product evaluation. Poisoning identification and Design, administration and monitoring of intravenous therapy. Selection of assessment of non-drug therapy Pharmacy systems management and economics. Emergency care treatment and assessment.	Content area for clinical function. Skill practice for function. Permits exploitation of function. Essential biological or physical science precursor. Social setting in which function takes place.

Basic Science Area	Clinical Pharmacy Practice Functions	Rationale
DRUG ACTION		
I. Drug Nomenclature and Classification	Drug information retrieval. Communications in the health care setting. Drug product evaluation. Drug therapy design and evaluation. Poisoning identification and treatment.	Content area for clinical function. Essential biological or physical science precursor. Skill practice for function. Permits exploitation of function.
II. Drug Action By Therapeutic Use	Communications in the health care setting. Drug production evaluation. Drug information retrieval. Poisoning identification and treatment. Emergency care treatment and assessment. Design, administration and monitoring of intravenous therapy. Selection and assessment of non-drug therapy.	Content area for clinical function. Permits exploitation of function. Biological of physical science application. Skill practice for function. Essential biological or physical science precursor.
III. Therapeutics Monitoring for Efficacy and Patient Education for Major Diseases	Drug therapy design and evaluation. Drug product evaluation. Drug information retrieval. Communications in health care setting. Poisoning identification and treatment. Emergency care treatment and assessment. Design, administration and monitoring of intravenous therapy. Drug administration.	Content area for clinical function. Permits exploitation of function Biological of physical science application. Skill practice for function.
PROVISION OR DELIVERY OF PHARMACEUTICAL SERVICES		
I. System for Health Care	Pharmacy systems management and economics. Communications in the health care setting. Interpretation of pharmacy laws and ethics.	Social setting in which function takes place. Biological or physical science application. Content area for clinical function. Essential behavioral science precursor. Behavioral science application. Permits exploitation of function Common area of input for clinical pharmacy.

Basic Science Area	Clinical Pharmacy Practice Function	Rationale
II. Human Behavior and Pharmacy	Drug therapy design and evaluation. Communications in the health care setting. Pharmacy systems management and economics.	Behavioral science application Skill practice for function. Content area for clinical function. Biological or physical science application. Permits exploitation of functi
III. Pharmacy Management	Interpretation of pharmacy law's and ethics.	Permits exploitation of functi Behavioral science application Essential behavioral science precursor. Content area for clinical function. Skill practice for function.
IV. Emergency Medical Services	Emergency care treatment. Poisoning identification and treatment. Drug therapy design and evaluation. Communications in the health care setting. Drug administration. Interpretation of pharmacy laws and ethics.	Content area for clinical function. Skill practice for function. Biological or physical science application. Behavioral science application. Permits exploitation of function.
V. Drug Information Evaluation	Drug information retrieval. Drug product evaluation. Drug therapy design and evaluation.	Skill practice for function. Biological or physical science application. Essential behavioral science precursor. Content area for clinical function. Essential biological or physical science precursor. Permits exploitation of function
VI. Drugs and the Elderly	Communications in the health care setting. Poisoning identification and treatment. Drug therapy design and evaluation. Drug administration	Skill practice for function. Behavioral science application. Social setting in which function takes place. Permits exploitation of function. Essential behavioral science precursor.

Basic Science Area	Clinical Pharmacy Practice Functions	Rationale
VII. Social and Psychological Aspects of Death and Dying	Communications in the health care setting. Drug Administration. Interpretation of pharmacy laws and ethics.	Content area for clinical function. Behavioral science application Skill practice for function. Social setting in which function takes place. Permits exploitating of function.
DOSAGE FORM DESIGN		
I. Physiochemical Properties and Biological Activity	Drug product evaluation. Design, administration and monitoring of intravenous therapy. Drug administration. Drug therapy design and evaluation.	Essential biological or physical science precursor. Biological or physical science application. Content area for clinical function.
II. Dosage Forms	Drug product evaluation. Drug therapy design and evaluation. Design, administration and monitoring of intravenous therapy. Drug administration.	Content area for clinical function. Biological or physical science application. Essential biological or physical science precursor. Skill practice for function. Permits exploitation of function.
III. Dispensing	Drug product evaluation. Design, administration and monitoring of intravenous therapy. Drug therapy design and evaluation. Drug administration. Selection and assessment of non-drug therapy.	Content area for clinical function. Skill practice for function. Permits exploitation of function. Biological or physical science application. Essential biological or physica science precursor.
IV. Biopharmaceutics	Drug product evaluation. Drug therapy design and evaluation. Drug administration.	Essential biological or science precursor. Permits exploitation of function. Content area for clinical function. Biological or physical science application.

Basic Science Area	Clinical Pharmacy Practice Functions	Rationale
V. Pharmacokinetics	Drug product evaluation.	Biological or physical science precursor.
	Drug therapy design and evaluation.	Permits exploitation of function.
	Drug administration.	Content area for clinical function.
		Essential biological or physical science precursor.
		Content area for clinical function.